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United States  
Department of  
Agriculture

Research and  
Education Committee

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# 1988 Annual Report on the Food and Agricultural Sciences

From the Secretary of Agriculture  
to the President and the Congress  
of the United States

1988  
36-19



## PREFACE

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This report was prepared under the auspices of the U.S. Department of Agriculture (USDA) Research and Education Committee, which was established in 1981 as a unit of the Secretary of Agriculture's Policy and Coordination Council. The Assistant Secretary of Agriculture for Science and Education serves as chairperson of the Committee.

USDA agency representatives who helped prepare this report were Jack H. Armstrong, Agricultural Cooperative Service; Harold S. Ricker, Agricultural Marketing Service; James T. Hall, Agricultural Research Service; Larry D. Mark, Animal and Plant Health Inspection Service; Fennie A. Tolver, Cooperative State Research Service; Verla C. Rape, Economic Research Service; Stuart H. Sutherland, Extension Service; Stephen Tanner, Federal Grain Inspection Service; Janet S. Wintermute, Forest Service; Alanna Mosfegh, Human Nutrition Information Service; Robert Butler, National Agricultural Library; Robert D. Tortora, National Agricultural Statistics Service; Michael L. Young, Office of Budget and Program Analysis; James S. Walker, Office of International Cooperation and Development; and Hunt B. Ashby, Office of Transportation.

Copies of this report can be obtained from James T. Hall, Executive Secretary, Research and Education Committee, USDA, Room 404, Building 005, BARC-W, Beltsville, MD 20705.

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## FEDERAL, STATE, AND PRIVATE INDUSTRY SUPPORT FOR THE FOOD AND AGRICULTURAL SCIENCES

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### DEPARTMENT OF AGRICULTURE

The U.S. Department of Agriculture's (USDA's) research and education (R&E) agencies supported food and agriculture research, Extension, and teaching programs funded at approximately \$1,422 million in FY 1988, up 3.8 percent from FY 1987. These programs were centered in the Agricultural Research Service, Cooperative State Research Service, Extension Service, National Agricultural Library, Forest Service, and Economic Research Service. Other agencies having research and education activities include the Agricultural Cooperative Service, Animal and Plant Health Inspection Service, Agricultural Marketing Service, Human Nutrition Information Service, Office of International Cooperation and Development, Office of Transportation, National Agricultural Statistics Service, and Federal Grain Inspection Service. USDA research and education program funding for fiscal year 1989 is estimated to be \$1,477 million (table 1).

The research and education programs of the Department are complementary and mutually supportive in providing new knowledge, technology, and information on food, agriculture, and forestry issues vital to producers, marketing firms, consumers, and action agencies. The results of these efforts affect the total economy of the United States and millions of consumers here and abroad. Including input supply, production, processing, and marketing, the agriculture and forestry sectors account for approximately 20 percent of the gross national product and employment in the United States. These sectors also provided \$16.1 billion in export trade surpluses in 1988. This helped to slightly offset huge trade deficits in other categories. At home, the cost of food to consumers as a share of disposable income continues to decline.

In 1988, estimates are that food required only about 11.8 percent of U.S. consumers' disposable income, down from 13.5 percent in 1978. At the farm level, food costs for U.S. consumers in 1988, as a percentage of disposable income, were only about 3 percent, since 75 percent of the cost of food is due to food marketing costs. In 1988, food processing cost \$296.8 billion, up nearly 5.0 percent from 1987. Labor costs alone for marketing, in 1988, were \$136 billion compared with \$97.5 billion for food at the U.S. farm level.

USDA research and education programs address national issues in production efficiency, export markets, marketing efficiency, biotechnology, natural resources management and conservation, human and community development, and human nutrition. Research and education programs financed by the Department, encompassing this complex array of issues, were approximately 2.4 percent of

the \$58.8 billion obligated for Federal research and development in FY 1988.

The Secretary of Agriculture has identified research and extension as one of the Department's five major goals. The research and education programs provide major underpinnings for the remaining goals, which are (1) a strong, healthy agricultural economy, (2) food and fiber for peace and economic stability, (3) resource conservation, and (4) support for State and local governments.

Funding for USDA research and education programs has increased in current dollars from \$1,093 million in FY 1981 to \$1,477 million for FY 1989 (table 1 and fig. 1). However, the gain in current dollars for research and education was more than offset by inflation over the period. In constant 1981 dollars, funding was nearly 2.0 percent less in FY 1989 than in FY 1981 (table 2 and fig. 2).

The overall R&E funding in constant dollars over the FY 1981-89 period has tended to vary only modestly. USDA funding for research in constant dollars was highest in 1985, and next highest in 1987. Funding for education in constant dollars declined in all years except 1982 and 1983 from 1981 to date (table 2 and fig. 2).

Differences in funding were apparent among the R&E agencies. Only five agencies operating R&E programs over the FY 1981-89 period had funding increases more than sufficient to cover inflation, and eight did not receive increases large enough to cover inflation (table 3).<sup>1</sup>

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<sup>1</sup>The Cooperative State Research Service received funding increases for research programs; however, the Agency did not receive large enough increases to cover inflation for its educational programs.

Table 1.  
U.S. Department of Agriculture: Appropriations for  
research and education, FY 1981-89

Item	1981	1982	1983	1984	1985	1986 <sup>1/</sup>	1987	1988	1989
	Million Dollars								
<u>RESEARCH</u>									
Agricultural Research Service <sup>2/</sup>	404.1	423.2	451.9	469.0	492.1	483.2	521.3	545.7	568.3
Cooperative State Research Service <sup>3/</sup>									
Hatch Act Formula	128.6	141.1	147.2	152.3	156.5	148.8	148.8	155.5	155.5
Cooperative Forestry	10.8	12.0	12.4	12.7	13.1	12.4	12.4	17.5	17.5
1890 Colleges and Tuskegee	19.3	21.5	21.8	22.8	23.5	22.3	22.3	23.3	24.3
Special Research Grants	18.2	23.1	27.8	26.5	32.0	29.0	55.1	50.6	61.8
Competitive Research Grants	16.0	16.3	17.0	17.0	46.0	42.3	40.7	42.4	39.7
Rural Development Research	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Animal Health and Disease	6.5	5.8	5.8	5.8	5.8	5.5	5.5	5.5	5.5
Direct Federal Administration	1.3	0.8	0.3	0.6	1.5	1.6	2.9	4.1	6.4
Forestry Competitive Grants	0.0	0.0	0.0	0.0	7.8	6.5	6.0	3.0	0.0
Total, CSRS <sup>3/</sup>	200.7	220.6	232.3	237.7	286.2	268.4	293.7	301.9	310.7
National Ag. Statistics Svc.									
Economic Research Service	7.5	7.0	7.6	8.2	8.4	8.0	3.4	3.6	3.7
Human Nutrition Info. Service	39.5	39.4	38.8	44.3	47.1	44.1	44.8	48.2	49.3
Animal & Plant Health Insp. Svc.	8.2	8.5	7.7	6.1	7.5	12.9	7.0	8.6	8.8
Agricultural Coop. Service	0.0	0.0	0.0	0.0	0.0	4.4	4.9	5.4	7.4
Agricultural Marketing Service	1.8	1.7	2.2	2.2	2.9	2.7	2.7	2.7	2.7
Office of Transportation	1.4	1.5	1.5	1.6	1.6	1.5	1.5	1.6	1.6
Office of Int. Coop. & Dev.	0.9	1.0	0.8	0.8	1.3	1.1	1.0	1.0	1.0
Forest Service	5.0	0.7	5.5	5.3	5.4	3.1	4.2	1.5	1.0
Federal Grain Inspection Service	108.4	112.1	107.7	108.7	113.8	113.6	126.7	132.5	137.9
Total, Research	0.5	0.6	0.6	0.7	1.1	0.9	0.8	1.0	1.1
	778.0	816.3	856.6	884.6	967.4	943.9	1012.0	1053.7	1,093.5
<u>EDUCATION</u>									
Extension Service <sup>4/</sup>									
Smith-Lever 3(b)(c) Formula	205.4	219.4	230.4	235.0	241.5	229.7	235.9	241.6	241.6
Other Extension Programs	80.7	90.0	92.8	93.8	96.8	93.1	96.8	99.4	110.7
Direct Federal Administration	6.1	6.3	5.4	5.5	5.4	5.2	6.3	7.4	9.1
Total, Extension Service <sup>4/</sup>	292.2	315.7	328.6	334.3	343.7	328.0	339.0	348.4	361.4
Cooperative State Research Service									
Bankhead-Jones	11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Morrill-Nelson	2.7	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Competitive Fellowship Grants	0.0	0.0	0.0	5.0	5.0	2.9	2.9	2.9	2.9
1890 Colleges Grants	0.0	0.0	0.0	2.0	1.9	1.9	1.9	1.9	1.9
Total, CSRS	14.2	2.8	2.8	7.8	9.8	7.6	7.6	7.6	7.6
National Agricultural Library									
Total, Education	8.2	8.2	9.1	10.4	11.5	10.8	11.1	12.2	14.3
	314.6	326.7	340.5	352.5	365.0	346.4	357.7	368.2	393.3
<b>TOTAL, Research &amp; Education</b>	<b>1092.6</b>	<b>1143.0</b>	<b>1197.1</b>	<b>1237.1</b>	<b>1332.4</b>	<b>1290.3</b>	<b>1369.7</b>	<b>1421.9</b>	<b>1476.8</b>

<sup>1/</sup> Reflects reductions under P.L. 99-177, the Balanced Budget and Emergency Deficit Control Act of 1985.

<sup>2/</sup> Excludes ARS construction funding, which has been (in millions of dollars): \$12.1 ('81), \$8.6 ('82), \$4.9 ('83), \$77.9 ('84), \$22.4 ('85), \$6.1 ('86), \$37.4 ('87), \$15.3 ('88), \$16.0 ('89).

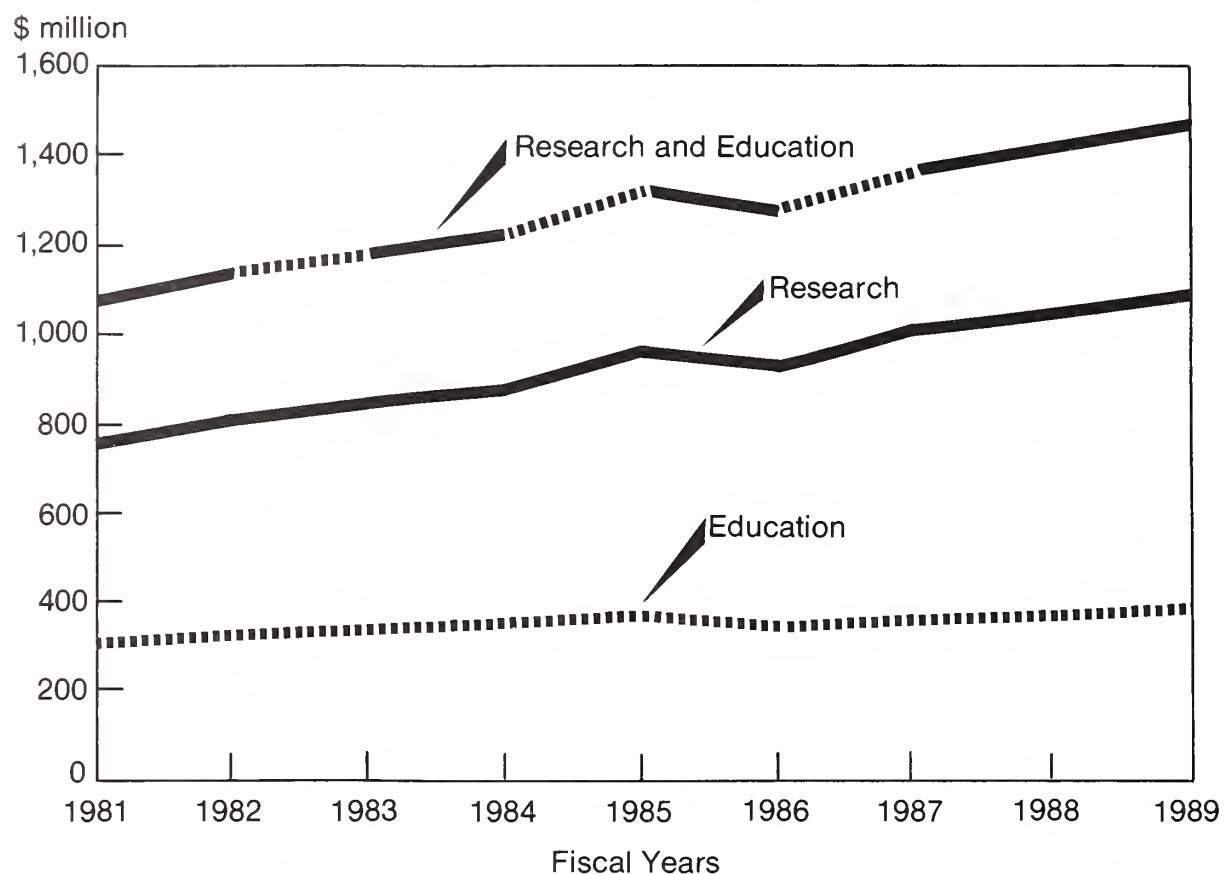
<sup>3/</sup> Excludes 1890 Colleges and Tuskegee Research Facilities funding, which has been \$10.0 million annually from FY '83 through FY '85; \$9.5 million each in FY '86 and FY '87; and facility funding in FY '87 of \$32.2 million, \$42.5 million in FY '88, and \$23 million in FY '89.

<sup>4/</sup> Excludes 1890 Colleges and Tuskegee Extension Facilities funding of \$9.5 million in FY '88 and \$9.5 million in FY '89.

Source: Office of Budget and Program Analysis (OBPA), USDA.

Figure 1

## USDA Appropriations for R & D (Current Dollars)



Source — OBPA, USDA

Table 2.

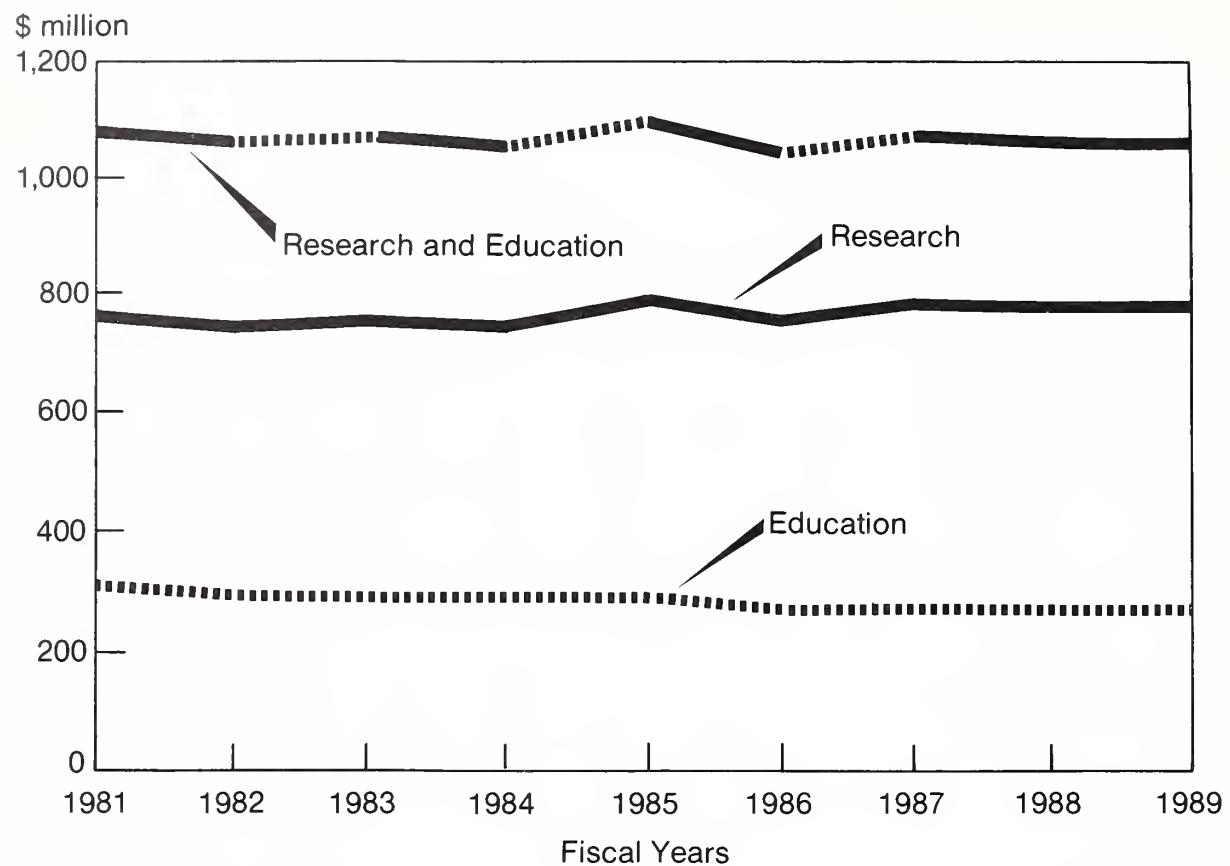
U.S. Department of Agriculture: Appropriations for research and education in constant 1981 dollars, FY 1981-89

Item	1981	1982	1983	1984	1985	1986	1987	1988	1989
Inflation rate	7.1%	4.0%	4.4%	3.4%	2.0%	3.4%	4.4%	4.0%	
GNP Deflator for Gov't. Purchases Index: (1982=100)	93.4	100.0	104.0	108.6	112.3	114.6	118.5	123.7	128.6
-----Million Dollars-----									
<u>RESEARCH</u>									
Agricultural Research Service	404.1	395.3	405.8	403.4	409.3	393.8	410.9	412.0	412.7
Cooperative State Research Service									
Hatch Act Formula	128.6	131.8	132.2	131.0	130.2	121.3	117.3	117.4	112.9
Cooperative Forestry	10.8	11.2	11.1	10.9	10.9	10.1	9.8	13.2	12.7
1890 Colleges and Tuskegee	19.3	20.1	19.6	19.6	19.5	18.2	17.6	17.6	17.6
Special Research Grants	18.2	21.6	25.0	22.8	26.6	23.6	43.4	38.2	44.9
Competitive Research Grants	16.0	15.2	15.3	14.6	38.3	34.5	32.1	32.0	28.8
Rural Development Research	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Animal Health and Disease	6.5	5.4	5.2	5.0	4.8	4.5	4.3	4.2	4.0
Direct Federal Administration	1.3	0.7	0.3	0.5	1.2	1.3	2.3	3.1	4.6
Forestry Competitive Grants	0.0	0.0	0.0	0.0	6.5	5.3	4.7	2.3	0.0
Total, CSRS	200.7	206.0	208.6	204.4	238.0	218.7	231.5	228.0	225.7
National Ag. Statistical Svc.	7.5	6.5	6.8	7.1	7.0	6.5	2.7	2.7	2.7
Economic Research Service	39.5	36.8	34.8	38.1	39.2	35.9	35.3	36.4	35.8
Human Nutrition Info. Service	8.2	7.9	6.9	5.2	6.2	10.5	5.5	6.5	6.4
Animal & Plant Health Insp. Svc.	0.0	0.0	0.0	0.0	0.0	3.6	3.9	4.1	5.4
Agricultural Coop. Service	1.8	1.6	2.0	1.9	2.4	2.2	2.1	2.0	
Agricultural Marketing Service	1.4	1.4	1.3	1.4	1.3	1.2	1.2	1.2	1.2
Office of Transportation	0.9	0.9	0.7	0.7	1.1	0.9	0.8	0.8	0.7
Office of Int. Coop. and Dev.	5.0	0.7	4.9	4.6	4.5	2.5	3.3	1.1	0.7
Forest Service	108.4	104.7	96.7	93.5	94.6	92.6	99.9	100.0	100.2
Federal Grain Inspection Service	0.5	0.6	0.5	0.6	0.9	0.7	0.6	0.8	0.8
Total, Research	778.0	762.4	769.3	760.8	804.6	769.3	797.6	795.6	794.2
<u>EDUCATION</u>									
Extension Service									
Smith-Lever 3(b&c) Formula	205.4	204.9	206.9	202.1	200.9	187.2	185.9	182.4	175.5
Other Extension Programs	80.7	84.1	83.3	80.7	80.5	75.9	76.3	75.1	80.4
Direct Federal Admin.	6.1	5.9	4.8	4.7	4.5	4.2	5.0	5.6	6.6
Total, Extension Service	292.2	294.9	295.1	287.5	285.9	267.3	267.2	263.1	262.5
Cooperative State Research Service									
Bankhead-Jones	11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Morrill-Nelson	2.7	2.6	2.5	2.4	2.3	2.3	2.2	2.1	2.0
Competitive Fellowship Grants	0.0	0.0	0.0	4.3	4.2	2.4	2.3	2.2	2.1
1890 Colleges Grants	0.0	0.0	0.0	0.0	1.7	1.5	1.5	1.4	1.4
Total, CSRS	14.2	2.6	2.5	6.7	8.2	6.2	6.0	5.7	5.5
National Agricultural Library	8.2	7.7	8.2	8.9	9.6	8.8	8.7	9.2	10.4
Total, Education	314.6	305.1	305.8	303.2	303.6	282.3	281.9	278.0	278.4
<b>TOTAL, Research and Education</b>	<b>1092.6</b>	<b>1067.6</b>	<b>1075.1</b>	<b>1064.0</b>	<b>1108.2</b>	<b>1051.6</b>	<b>1079.6</b>	<b>1073.6</b>	<b>1072.6</b>

Source: OBP, USDA.

Figure 2

### USDA Appropriations for R & D (Constant Dollars)



Source — OBPA, USDA

Table 3.

U.S. Department of Agriculture: Percent changes in appropriations for research and education programs, by Agency, from FY 1981 to 1989 in constant 1981 and current dollars

<u>Agency</u>	Constant 1981 dollars	Current dollars
<u>Research</u>	<u>Percent</u>	<u>Percent</u>
Agricultural Research Service	+2.1	+40.6
Cooperative State Research Service	+12.5	+54.8
National Agricultural Statistics Service	-64.0	-50.6
Economic Research Service	-9.4	+24.8
Human Nutrition Information Service	-22.0	+7.3
Animal and Plant Health Inspection Service	--	--
Agricultural Cooperative Service	+11.1	+50.0
Agricultural Marketing Service	-14.3	+14.3
Office of Transportation	-22.2	+11.1
Office of International Cooperation and Devel.	-86.0	-80.0
Forest Service	-7.6	+27.2
Federal Grain Inspection Service	+60.0	+120.0
Total, research	<u>+2.1</u>	<u>+40.6</u>
<u>Education</u>		
Extension Service	-10.2	+23.7
Cooperative State Research Service	-61.3	-46.5
National Agricultural Library	<u>+26.8</u>	<u>+73.1</u>
Total, education	<u>-11.5</u>	<u>+21.8</u>
Total, research and education	-1.8	+37.0

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#### STATE AND COUNTY SUPPORT

State and county support for research and extension for the food, fiber, and forestry system at about \$1.7 billion per year is slightly higher than that of the Federal contribution of about \$1.4 billion. Combined Federal, State, and county funds support approximately 10,000 scientists and 15,000 extension personnel, who are the formulators and extenders of knowledge needed by the Nation's largest industry. Public investment in food and agriculture research and education has consistently provided annual returns of 30 percent or more.

State support for the food and agricultural sciences is provided primarily through the land-grant institutions (1862, 1890, forestry schools, and Tuskegee Institute) and includes funds for research, extension, and higher education. However, an estimated 50 State-supported, non-land-grant institutions also have agricultural programs. These programs are primarily devoted to higher education.

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#### PRIVATE INDUSTRY RESEARCH AND DEVELOPMENT

The report "A Survey of U.S. Agricultural Research by Private Industry III" published in July 1985 by the Agricultural Research Institute (ARI) of Bethesda, MD, stated that "the best estimate of private industry annual expenditures in agricultural research (is) approximately 2.1 billion dollars."

Based on ARI data, industry overall is apparently devoting approximately 15 percent of its research and development expenditures to basic research, 43.5 percent to applied research, and 41.5 percent to developmental research. However, 62 percent of the companies responding to an ARI survey reported doing no basic research and 36.5 percent reported doing no research of any kind.

Major areas of research conducted by industry, as reported by ARI, are in pesticides, plant breeding, and human food. These three areas accounted for nearly two-thirds of the agricultural research carried on by industry.

## SELECTED SIGNIFICANT ACTIVITIES AND ACCOMPLISHMENTS IN THE FOOD AND AGRICULTURAL SCIENCES

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### AGRICULTURAL RESEARCH SERVICE

The Agricultural Research Service (ARS) conducts mission-oriented research to ensure a continuing abundance of high-quality, nutritious, reasonably priced food and other agricultural products to meet domestic and world needs while maintaining environmental quality. ARS uses coordinated, interdisciplinary approaches to conduct basic and applied research pertaining to soil and water conservation, plant sciences, animal sciences, commodity conversion and delivery, human nutrition, and integration of agricultural systems.

Research is conducted at numerous locations in the United States, and in Puerto Rico, the Virgin Islands, and several foreign countries. When appropriate, the research is conducted in cooperation with the State agricultural experiment stations, other State and Federal agencies, and private institutions.

**Technology Transfer Research and Development Agreements With Industry Firms** In FY '88 ARS signed 39 Technology Transfer Cooperative Research and Development Agreements (CRDAs) with industry firms to help speed commercialization of new products and processes made possible by ARS research. Technologies which were nearing the commercial stage of development at the end of FY '88, as a result of CRDAs signed in FY '87, included a plant virus disease detection test kit and a method to mass inoculate chickens by mechanical injection of vaccine into hatching eggs.

**Corn Yields Increased by Ridge Tillage and Controlled Traffic** Farmers can advance their planting dates and increase corn yields by changing tillage practices and restricting vehicle traffic over clay soils. ARS scientists believe that by planting corn on raised beds of soil--called ridge tillage--and restricting farm equipment traffic over fields to predetermined lanes, farmers can restrict the zones of soil compaction, reduce damage to the soil structure, and minimize depletion of organic matter. These practices were followed in test plots at Columbus, OH, on Hoytville silty clay that had been severely compacted previously by conventional tillage; the results were an advancement of planting dates by an average of 12 days and almost doubled yields.

**New Planter Positions Seeds for Optimum Germination** ARS has developed a planter with an interactive depth and down-pressure control system that automatically plants seeds at the same depth regardless of variations in soil height or density. Such uniformity can increase germination and seedling emergence rates (seeds planted too near the surface dry out, and seeds buried too deeply won't emerge). Uniform seed depths could also increase the effectiveness of chemical applications and improve harvest quality by promoting uniformity in crop growth and maturity.

**Kenaf Harvester  
Prototype Developed**

Kenaf, a new crop for the United States, can now be machine harvested. Kenaf yields several kinds of high-quality fibers, one of which is equal or superior to wood pulp in the production of newsprint. Other kenaf fibers are being evaluated for use in a broad array of products, including felts, carpet pads, and auto headliners and dashes. They are also being evaluated as a composting medium for city sludge. This annual crop also produces considerably more fiber per acre per year than tree sources. One of the major hurdles to date has been the means to harvest this 15-foot-tall crop. However, a prototype machine has now been constructed that harvests kenaf efficiently. This will allow the planting of larger acreages needed for further market development research and eventual commercialization of kenaf.

**Biocontrol of  
Russian Wheat  
Aphid**

The Russian wheat aphid entered the United States over 2 years ago via Mexico and now infests 15 Western States, seriously threatening the wheat and barley industry. Since the Russian wheat aphid is not native to the United States, it has no effective natural enemies here. To overcome this problem, ARS has begun to import parasites, predators, and diseases of this insect pest. Scientists of the ARS European Parasite Laboratory have made several explorations into Turkey, where the Russian wheat aphid occurs. Near Ankara, scientists found seven parasites, seven predators, and four different diseases associated with the Russian wheat aphid. These natural enemies were collected and sent to the United States through the ARS quarantine facility at Newark, DE. From there they were sent to both State and ARS laboratories and are now being introduced into fields, where their survival and efficiency in controlling the Russian wheat aphid will be assessed. Further foreign explorations are underway to identify other potentially valuable biological agents.

**Rice Variety Lowers  
Cost by 34 Percent**

Lemont, a rice variety developed cooperatively by ARS and Texas A&M researchers, had an economic impact of over \$1 billion in Texas, Louisiana, Arkansas, and Mississippi between 1983, when it was released, and 1987. Lemont, one of the first semidwarf rice varieties developed for the Southern United States has lowered production costs in the region from \$12.43 per hundred pounds in 1983 to \$8.20 in 1987. Because it is high yielding, has excellent quality, and resists lodging or falling down in high winds, Lemont has become one of the major rice cultivars grown in the United States.

**Biological Agents  
Control Cotton  
Diseases**

Seedling diseases of cotton are a major concern for U.S. growers, accounting for annual losses of more than 230,000 bales of cotton, worth nearly \$72 million. While no single practice can solve seedling disease problems in cotton, new in-furrow and seed treatments have been developed that include using antagonistic microorganisms that protect cotton seedlings from infection by soilborne fungal pathogens.

New Harvester  
Reduces Hay Losses

Forages are among the top four crops in the United States in terms of acreage, and their value is approximately \$10 billion annually. Unfortunately, 20 to 30 percent of the nutritive value of forages may be lost during harvest and storage. A process developed at the ARS Dairy Forage Research Center makes it possible to field-dry forage crops in less than 6 hours under good weather conditions. In field tests with a prototype machine, researchers cut alfalfa in the morning and baled it in the afternoon--all in less than 6 hours. With a conventional machine called a mower-conditioner, 2 to 4 days are needed to dry hay to the 20-percent moisture content needed for baling. The new machine shreds the alfalfa immediately after mowing and forms the hay into thin, continuous mats that are laid on stubble for drying. After drying, the forage mats can be harvested and stored as silage or hay with conventional equipment. This improved technology represents an economic opportunity for farm equipment manufacturers and provides farmers with higher quality, more digestible silage or hay.

Reduced Chemical  
Use Possible on  
Alfalfa

ARS scientists demonstrated that a fungal pathogen originally discovered in Brazil readily infects and kills potato leaf-hoppers that feed on alfalfa. The fungus can be produced in the laboratory and then applied to the alfalfa plants. The use of this biological control agent will make it possible to apply less chemical insecticides that can contaminate surface and ground water.

Edible Beans  
Resistant to 33  
Races of Rust

Super-rust-resistant beans could lower farmers' need to spray pesticides and thus reduce pesticide residue in the environment. Rust, one of the most damaging bean leaf diseases, costs U.S. farmers up to \$250 million yearly. The rust fungus, *Uromyces appendiculatus*, is a genetic quick-change artist that can develop new strains to attack formerly resistant bean varieties. ARS scientists have now developed germplasm with resistance to more than 30 races of rust. This resistance has been transferred into snap, wax, pinto, navy, pink, black, red Mexican, and great northern beans. Seed companies are using this germplasm to develop super-rust-resistant varieties.

Cattle Grub Vaccine  
Developed

A vaccine to protect cattle from the cattle grub has been developed by ARS scientists in cooperation with a biotechnology company. Cloned recombinant antigen is being used to stimulate an immune response in calves during an experimental evaluation now under way. When the vaccine is successfully commercialized, it will enable ranchers to protect their livestock from cattle grub infestations that are estimated to cost the industry in excess of \$600 million per year.

Turkey Fertility  
Improved

Several factors influence turkey egg hatchability, which is much lower (73 percent) than that of layer chickens (93 percent).

Biotin deficiency is only a part of this hatchability problem. In studies with 14,000 eggs, 3 to 4 percent more turkey eggs hatched when injected with biotin. The automated injection was given on the 25th day of the normal 28-day incubation period. Turkey embryos are deficient in this vitamin essential to fat and protein metabolism. Low hatching rates cost the turkey industry about \$70 million annually. Scientists estimate \$500,000 in annual savings if the vitamin injection increases hatchability by only 1 percent of the 50 million eggs laid annually.

**Preventing Aflatoxin Poisoning in Pigs**

Mold contamination of feeds and grains may cause a buildup of poisons called mycotoxins. Aflatoxin (a specific type of mycotoxin) can adversely affect the swine and pork industry by causing reduced growth, increased incidence of disease, poor fertility, and death. In recent tests, an anticaking compound for feeds (hydrated sodium calcium aluminosilicate, HSCAS) inactivated aflatoxins. The present study evaluated the ability of HSCAS to prevent aflatoxin poisoning in pigs. Growing pigs were completely protected from the ill effects of aflatoxins by HSCAS. The use of HSCAS to prevent aflatoxin poisoning could help the swine industry save losses from a very costly disease.

**Supercomputer Evaluates 10 Million Dairy Cows**

More accurate genetic evaluations are now possible for dairy animals. An animal model is a system for evaluating the genetic ability of cows to produce milk. The animal model is recognized as the most accurate approach to genetic evaluation because information from all relatives of the animal are used. The model evaluates the genetic merits of mates for males and those of offspring for females. Until supercomputers became available, computational requirements for implementing the animal model were too great. Recently, the system's effectiveness was demonstrated in the evaluation of more than 10 million Holstein dairy cows.

**Nectarines Exported to Japan**

The codling moth, a serious insect pest of fruit crops, has historically prevented Japan from importing U.S. nectarines. ARS research has shown that fumigation with methyl bromide will kill all codling moths. A fumigation schedule was accepted by Japan in time to allow 40,000 11-pound cartons to be shipped between June 28 and July 25, 1988. U.S. shippers expect to export 100,000 to 150,000 cartons in 1989 and estimate Japan's potential market at 1 million cartons per year, or about 5 percent of California's crop.

**Stronger Cotton-Blend Yarns Improve Permanent Press Fabric**

A simple mechanical device, mounted on a conventional ring-spinning machine, can--with the addition of minor amounts of polyester fiber--make cotton-blend yarns that are stronger than conventional yarns. Surface and feel of these yarns are those of 100 percent cotton; yet strength and resistance to

abrasion are enhanced. The method should lead to improved permanent press fabrics high in cotton content. Because it is simple to adapt the technology to current ring-spinning equipment, several textile firms have expressed interest, and patent applications are being filed.

Industrial Products from Corn

Starch has been converted in a twin-screw extruder to glycol glucosides. These compounds are of commercial interest for the preparation of urethane foams, alkyd resins, surfactants, and other products. Experiments are in progress to convert corn starches and flours into the glucosides and to develop a process for using the glucosides to make urethane.

Peanut Quality Improved

A new ARS-developed machine that rapidly screens farmer-stock peanuts prior to storage will improve the economic efficiency of the peanut shelling industry and the competitive position of U.S. peanuts in foreign markets. The new machine uses flexible belts that are spaced to separate field debris, loose kernels, and small immature pods from the inshell peanuts. Previous research showed that removal of these components will significantly improve peanut quality and wholesomeness. The machine also has the potential to efficiently clean shelled peanuts and other crops such as soybeans, pecans, walnuts, and pistachios. Pilot-scale evaluation of this technology during the 1988 harvest was a cooperative effort of USDA and all components of the peanut industry--farmers, shellers, and manufacturers. Implementation of this technology by the storage and shelling sectors of the industry should assure the continuance of U.S. peanuts to meet the ever-narrowing quality specifications of the European market.

Fortified Breast Milk Aids Premature Babies

Scientists at ARS' Children's Nutrition Research Center have made progress in fortifying human breast milk with calcium and phosphorus in a form that premature infants can absorb. A shortage of these minerals can slow growth, impair healing of lung tissue, and lead to bone malformations. Tube feeding of mothers' milk from birth is preferred because it is more digestible than commercial formulas and contains immune factors including a form of iron (lactoferrin) which helps infants fight infection. Lactoferrin is also believed to increase the rate of protein synthesis and gastrointestinal tract development. Thus far, infants fed the fortified breast milk formula have absorbed more calcium and phosphorus than control infants fed two different commercial formulas.

Iron Status Influences Cold Tolerance

A study with women revealed that a low iron status reduced their ability to regulate or maintain body temperature in the cold, thereby rendering them more susceptible to cold temperatures. For 80 days, six healthy young women followed diets that contained less than one-third the Recommended Dietary

Allowance for iron (4 mg/day). A reduced ability to maintain body temperature during acute cold exposure then occurred from their low iron status--even though they were not anemic. The iron-depleted women not only generated less body heat when exposed to the cold but also lost more body heat than they did after a 114-day iron-repleting regimen. More than half the population of American women between ages 11 and 50 consume less than the recommended iron intake, which could explain why some women may be more affected by cold than others.

**Cholesterol Content  
of Eggs Updated**

ARS, the Agricultural Marketing Service, and Human Nutrition Information Service (HNIS) are assisting the egg industry with a nationwide study to determine the cholesterol content of shell eggs. ARS helped to develop appropriate analytical methods and to select a research laboratory to perform the tests. The findings, expected by the spring of 1989, will be considered by HNIS when the nutrient data base for Agriculture Handbook 8-1 ("Composition of Foods: Dairy and Egg Products") is updated. Also, the findings will be useful to other Government agencies when questions about egg product labeling and advertising arise.

**Computer Program  
Saves Water**

SCHED, a model that schedules irrigation, has cut energy costs by about 15 percent and can cut water use up to 30 percent by telling farmers when crops need water. The main advantage of this latest irrigation-scheduling program is that it is easier to use than older programs yet is accurate in predicting crop water needs. Special weather information, such as solar radiation data, supplied by some local radio stations or newspapers can be used to run the software program. For slightly more accurate results, users can enter onfarm weather data they collect themselves. Weather and soil moisture data are electronically transmitted to the system at the farm headquarters from fields up to 6 miles away. Using this information and crop requirement data, the computer then recommends which pumps could be turned off to keep power consumption down and still keep crop yield up.

**Controlled Traffic  
Reduces Soil  
Compaction and Costs**

Soil compacted by tractor wheels inhibits crop root growth and often reduces crop yield, especially of deep-rooted crops such as cotton. Research has led to the development of a cotton production system that restricts wheel traffic to predetermined traffic zones during crop production from year to year. Conventional crop production equipment was modified to accommodate a planting pattern of double rows, 40 inches apart, separated by 58 inches. All tractor and harvester wheel traffic is limited to the center 20 inches of the 58-inch spacing. In tests of this system, deep tillage (subsoiling) was not required for up to 6 years and yields were equal to those obtained from cotton planted in solid 40-inch rows and subsoiled each year. The system also reduced production costs by \$42 per acre.

Forty Expert Systems  
Under Development

EXTRA (Expert Systems for Technology and Resource Conservation in Agriculture) is a multi-State, multiagency, and public- and private-sector effort that has progressed to the point that more than 100 researchers are working on over 40 expert systems. Involvement is divided into five areas: crop production, pest management, animal production, land and water, and tillage. Selected users evaluated and tested prototype software designed to provide advice on grain marketing, on double cropping of soybeans following winter wheat, and on the relationships of conservation tillage practices to corn and soybean yield. The expert systems were preferred by users over human experts because the systems were more available, allowed users to explore alternatives at their own pace, and seemed to provide more thorough information.

Weed Control Model  
Raises Net Returns  
and Aids Environment

ARS Scientists at Fort Collins, CO, have developed a "bioeconomic model" to help farmers choose a cost-effective weed control program that will help maximize profits. The model bases decisions on current-week pressure in the field, expected yield and grain prices, and cost of the various herbicides. Results of limited field trials indicate an increase of as much as \$30 per acre in net return and a reduction of up to 85 percent in the use of chemicals.

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## COOPERATIVE STATE RESEARCH SERVICE

The mission of the Cooperative State Research Service (CSRS) is to advance science and technology in support of agriculture, forestry, people, and communities; in partnership with the State agricultural experiment station system, colleges, universities, and other research organizations; and in consonance with the Secretary of Agriculture and the intent of Congress. CSRS scientists work with regional and national groups to assure the quality of science and to set research priorities. The agency administers USDA research funds appropriated by Congress for the States, gives focus to the broad programs of agricultural research and education in the States, and participates in a nationwide system of research planning and coordination. It also supports and encourages efforts aimed at providing the food and agricultural expertise required by the Nation.

### State Cooperators

CSRS programs are carried out cooperatively with:

- o 59 State and territorial agricultural experiment stations;
- o 17 colleges of 1890, including Tuskegee University;
- o 28 schools of forestry; and
- o 28 colleges of veterinary medicine.

Most of these institutions are associated with the land-grant universities. When all publicly supported agricultural research is taken into account, including all research agencies within USDA, two-thirds of the full-time equivalent scientist years are found in the State agricultural experiment station system. Because of shared responsibilities between research and teaching in the universities, the actual number of scientists is far larger. This provides a wide range of talent capable of addressing most kinds of problems faced by agriculture.

### Commercial Process Developed for Low-Cholesterol Milk

Researchers at the Cornell University Agricultural Experiment Station have improved a process to remove cholesterol from milk to the point where the process can be said to be commercially viable. The continuous process can remove 90 percent of the cholesterol in milk and involves forcing carbon dioxide through the fat in milk at pressures more than 1,300 times the pressure found in the average automobile tire. The technique, similar to the one used to decaffeinate coffee, opens the way for producing low-cholesterol milk and other dairy products, such as butter, ice cream, cheese, and yogurt. The process, known as "supercritical fluid extraction," could have a worldwide impact on the dairy industry.

#### Using Salty Water To Irrigate Crops

Researchers at the Utah Agricultural Experiment Station are irrigating crops with salty wastewater from a power plant, a practice that could save millions of dollars that would otherwise be required for disposal. Crop management would also be improved by the sophisticated electronic monitoring techniques used to determine how plant growth and water use are affected by salty water. The wastewater was about 10 times more saline than freshwater from a nearby river. Researchers are now determining the minimum amount of leaching required to prevent yield depression. Salty water reduces the yields of some crops, but the decrease appears to be related more to boron toxicity than to salinity. Management techniques are being developed to deal with excess boron. Better management of saline soils and the use of saline water for irrigation will have widespread application around the world.

#### Multiparented Pig Provides New Answers

University of Missouri animal scientists have produced the first live pig derived from multiple parents. This very unique pig has two sires, two dams, and a surrogate mother and is providing new information about reproduction, particularly the hybrid vigor (heterosis) resulting from crossbreeding. The pig was produced by a five-step procedure: (1) mate two sets of parents, (2) very early in pregnancy, take an embryo from each sow, (3) by microsurgery, take a cell from one embryo and put it into another, (4) grow the fused embryo in culture for about 5 hours, and (5) put the embryo into the uterus of a surrogate mother, where it is nurtured until birth. This procedure provides a means of obtaining valuable information for reducing embryonic death in livestock.

#### Lean, High-Protein Hotdogs

Approximately 5 billion pounds of sausage-type (franks and bologna) products, with a 30-percent average fat content, are produced annually in the United States. Texas Agricultural Experiment Station scientists showed that nonmeat protein sources can be successfully incorporated into finely chopped meat products as a substitute for fat. By successively substituting soy protein concentrate and vital wheat gluten for fat, and concomitantly modifying flavor, researchers first produced a hotdog with 22-percent fat and now one with 15 percent fat. Changes in the product were achieved with minimum effects on processing yield and sensory attributes, such as taste, smell, and texture. If just a 22-percent-fat hotdog were adopted industrywide, 400 million pounds of fat would be removed each year from the American diet.

#### Caffeine-Free Tea

The tea industry may take a healthier turn in as few as 3 years if a Clemson University scientist's research to breed a tea that is naturally caffeine free is successful. Some decaffeinated teas are currently on the market, but the caffeine has been extracted from the plants. Using tissue culture, the

scientist plans to produce plants that have little or no caffeine. Such plants can be developed more quickly by tissue culture than by conventional breeding techniques, since changes in the plant's metabolism can be studied immediately. Woody tissue, such as tea, is more difficult to culture than herbaceous tissue. Woody tissue harbors more microorganisms, making it more difficult for researchers to obtain sterile cultures. This type of research, which represents a genetic engineering approach, could be useful in other crop development areas if discoveries are made. Officials from tea-producing countries such as China and Sri Lanka and from several such countries in Africa have shown interest in this research.

Fat-Absorbent  
Cooking Pad  
Reduces  
Calories in  
Food

Good news for calorie-conscious consumers! A new, highly-fat-absorbent microwave cooking package, studied by researchers at the University of Tennessee, reduces fat in bacon by more than half. In tests, bacon cooked on the absorbent material contained 58.8 percent less fat than bacon microwaved on paper towels (2.3 grams vs. 5.6 grams of fat per slice of cooked bacon). In microwave cooking, the new packaging actually helps texture and tenderness because it absorbs more grease and less moisture than paper towels. The initial research shows that this new type of cooking package can contribute significantly to decreasing the amount of fat in the diet. Researchers believe this cooking technique will have numerous applications in the restaurant industry as well as in the home.

Inexpensive  
Method for  
Storing  
Leafy Green  
Vegetables

Leafy greens delivered to market in ice-walled containers increase profits for farmers, stay fresh longer on the shelf, and are crisper and crunchier as salad ingredients. Keeping greens cool and unwilted from field to market is often a challenge, especially for small-scale farmers who cannot afford sophisticated refrigeration equipment. Agricultural engineers at the Fort Valley State College, GA, have developed a low-cost container with a lining which can be filled with water and frozen. As the ice melts, water drips slowly onto the greens through microscopic holes in the lining, keeping them cool and fresher during harvest, storage, and transportation. The greens maintain top-quality for consumers and bring in better prices for farmers.

Nonchemical  
Method for  
Controlling  
Weeds

Soil solarization is a special mulching process that utilizes solar energy to cause hydrothermal disinfestation. It also causes chemical and biological changes in soil, reduces soilborne pests, and stimulates growth and yield of crops. This treatment increased soil temperature by 7-12 degrees Celsius, up to 57 degrees Celsius in the top 5 centimeters. Tuskegee University scientists showed that soil solarization controlled weeds such as purple nutsedge, crabgrass, barnyard grass, Florida purslane, pigweed, cocklebur, morning glory, and coffee

weed in some locations. Vegetables such as collard greens and sweet potatoes grew larger and produced better yields in solarized soil than in nonsolarized soil. As compared to herbicide treatment, solarization is economical, simple, and nonhazardous because it does not employ toxic materials.

Improved  
Marek's  
Disease  
Vaccines

Studies at the University of Georgia College of Veterinary Medicine offer new insight into immunological mechanisms that protect chickens against Marek's disease, a cancerlike disorder caused by a herpes virus. Although live vaccines are widely used to prevent Marek's disease tumors in commercial chickens, such vaccines do not prevent infection by the field-strain virus. Investigations with inbred chickens have demonstrated that immunization with laboratory-grown virus-nonproducer cells derived from Marek's disease tumors of the same inbred stock not only prevents tumor development effectively but also inhibits replication and spread of the Marek's virus. The results indicate that it is possible to genetically engineer vaccines for Marek's disease so that they will induce the immune cells to cause antiviral as well as antitumor immunity.

New Crops  
Introduced

Because consumer interest in specialty vegetables is increasing, the Connecticut Agricultural Experiment Station in New Haven has been exploring ways Connecticut farmers can grow new crops to help meet increased demand. Several of the crops being tried are witloof chicory (also known as Belgian endive) and radicchio, both generally imported from Europe, and globe artichokes, generally grown in California. Each of these crops represents an opportunity for farmers to keep their farms in production in an increasingly urbanized State and to gain a new source of income while at the same time giving consumers fresher produce that has not traveled thousands of miles before reaching market.

Manufacture of  
Waferboard

The introduction of the waferboard industry to Minnesota has resulted in improved markets for forest trees, employment for numerous workers, and an enlarged tax base. Researchers in the Department of Forest Products, University of Minnesota, studied the utilization of Lake States hardwoods for structural panel products. Waferboard manufactured from underutilized species proved to be competitive with other wood-panel products. This study provided much of the information that has resulted in Minnesota becoming one of the major particleboard-producing States.

Nitrogen  
Fixation Genes  
Sequenced

At Virginia Polytechnic Institute and State University genetic engineers specializing in nitrogen fixation have determined the complete nucleotide sequence of genes that are required for biological nitrogen fixation. This determination brings agricultural scientists a significant step closer to

engineering the microorganisms which enable some crop plants to convert nitrogen in the air to a nutrient. Working with the nitrogen fixer Azotobacter vinelandii as a model, the researchers developed and implemented the genetic technology required to modify the enzyme responsible for nitrogen fixation. If certain microbes could fix nitrogen more efficiently, their utilization could be a major step toward ensuring a sufficient food supply and reducing the vast expense of producing nitrogen fertilizers. More important, an eventual result of nitrogen fixation research could help Third World subsistence farmers boost production.

#### Aquaculture Research

A study at the University of California on ovarian maturation in domestically reared white sturgeon has led to a better understanding of the reproductive physiology of this species. Evaluations of hormonal implants to stimulate vitellogenesis and ovarian maturation are promising. Results of this study will allow aquaculturists to control spawning of domestically reared brood stock and ensure dependable sources of high quality fingerlings. Additionally, information obtained from this study can be applied to other cultured species.

#### Biotechnology

Photosynthesis, the major physiological process, represents the source of essentially all organic carbon. When photosynthesis is depressed by stress, plant growth is reduced. Researchers at the University of Nevada have been following the biochemical basis of the reduction in photosynthetic capacity associated with environmental stresses (salinity, water stress). A newly discovered effect in the activity of the carbon dioxide fixing enzyme, RuBCase, is the primary cause of reduced photosynthetic activity. Research is continuing on stress-related factors which reduce the efficiency of photosynthesis and RuBCase.

#### Computerized Information System

A new and unique computerized information system known as the Food and Agricultural Sciences Education Information System (FAEIS) was introduced nationwide. FAEIS provides direct online access to a comprehensive array of current and historic data essential to higher education planning and evaluation such as enrollments, degrees conferred, student support, placement of graduates, employment opportunities for graduates, and faculty information. This system is the only one of its kind in the Nation.

#### Nurturing the Development of Scientific and Professional Expertise

Since 1984, the National Needs Graduate Fellowships Grants Program has contributed importantly toward reducing the serious erosion of our expertise on food and agricultural sciences. The average graduate-record examination score of the 418 fellows supported by the program is more than 300 points higher than that of average graduate students in agriculture. For the

fourth consecutive year, strengthening grants have been provided to the 1890 land-grant institutions and Tuskegee University to enhance their curriculum, faculty, instrumentation, and recruitment of outstanding students. Other high priority national initiatives CSRS undertook to improve the infrastructure of the Nation's higher education system concerning the food and agricultural sciences include supporting the following innovative national projects: a marketing study by the American College Testing Program to assess the image of food and agricultural science and business careers as perceived by high school students, an agribusiness education development project aimed at recommending strategies and mechanisms to produce a new generation of graduates with managerial and leadership skills for competing in today's global market, and a national teleconference that emanated from "The Land" at Disney World's EPCOT Center and that involved more than 3 million elementary and secondary students to stimulate their interest in becoming food or agricultural scientists or professionals.

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## NATIONAL AGRICULTURAL STATISTICS SERVICE

The National Agricultural Statistics Service (NASS) conducts research to improve the statistical methods and techniques used to produce agricultural statistics. This research is done in support of the NASS long-range program for improving the accuracy of crop and livestock estimates at minimum cost and is directed toward better sampling, yield forecasting, survey techniques, and quality assurance procedures. Some highlights of research accomplished in FY 1988 follow.

### Improved Estimator

NASS currently calculates four estimators for each hog survey category from data obtained during the June midyear surveys. Research was completed which produced a method to statistically average the survey estimates into a single composite estimate. The smoothed inverse-variance method of composite estimation was used to make operational hog estimates during the June 1988 midyear survey.

### Objective Yield Research and Analysis

The final year of data collection for a research study to evaluate an alternative estimator for the Corn Objective Yield Survey was completed. Surface area and volume measurement of immature corn ears are used to predict final ear weight. Preliminary analyses are promising, with reductions in forecast errors of about 15 percent.

Because of the 1988 drought, the four-State pilot test of an improved early forecast model for corn ear weight based on daily weather data was expanded to all 10 States involved in the Corn Objective Yield Survey (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Nebraska, Ohio, South Dakota, and Wisconsin). Results of the test were mixed. The model did produce ear weights closer to the final, end-of-season ear weight in nearly all States. However, the gains in some States were very slight. Current research is attempting to allow growing conditions prior to tassel initiation to influence the ear weight prediction more. In addition, another new regression model was tried during 1988 and proved to be considerably better than the previous model.

A cooperative agreement was initiated with Texas A&M University to develop compartmental forecast models of cotton yield. These models are more nonparametric and more robust to modeling assumptions. Data are classified based upon several categorical variables; then yield forecasts are made based upon historical samples similarly classified.

### Farm Cost and Return Survey Research

The cooperative agreement on the Farm Cost and Return Survey (FCRS) with the University of Georgia is almost completed. This research will permit several types of multivariate statistical

analyses over the next year. Better methods for editing, data imputation, and questionnaire design should result. Reductions in questionnaire size are unlikely. In addition, data were collected to evaluate the use of organized farm-recordkeeping systems in FCRS in order to enhance the quality of the data and also ease the respondent's burden. An initial pilot study provided basic information about recordkeeping systems: their organization, their differences and similarities, their utilization by farm operators, and factors that characterize their users. Results have provided a foundation for possibly reconsidering the FCRS survey design and data collection methods.

Prices Received Analysis

Various time-series modeling methods are being explored to produce midmonth price estimates that are closer to the final end-of-month prices than the current midmonth price estimates. The new methods would allow the additional advantage of incorporating more current check data than the amount of such data used in the operational method. A preliminary research report has demonstrated substantial promise.

Livestock Slaughter Edit

Longitudinal time-series edits (data checks) were developed from previous-year data for each firm to produce its unique edit limits. Rate of kill, patterns of kill, types of animals slaughtered, and average weight appropriate to a firm are a few of the specialized edits. Specifications for a new edit system are being completed.

Computer-Assisted Stratification of Area Frames

NASS is involved in a cooperative effort with the National Aeronautics and Space Administration (NASA) to develop area sampling frames using digital inputs. The project with NASA will extend over 3 years. NASA will provide software support through the Ecosystem Science and Technology Branch (ECOSAT), located at Ames Research Center, Moffett Field, CA. This project will explore the use of digital satellite data and digital line-graph data in the development of area frames. This system will allow the operator to delineate areas of homogeneous land parcels, called primary sampling units, onscreen so that the use of paper-based material, transfer of boundaries from photography to the map base, and the digitization process (used to measure the area) may be eliminated. This system will improve the use of previously classified satellite data as an aid in the stratification process and will allow updating of area frames. Three counties in Missouri were stratified in phase 1. Twenty counties in Michigan will be stratified in phase 2.

Computer-Assisted Livestock Price Recording

Research is being conducted on recording livestock prices directly into a lap-top computer, bypassing the paper recording and subsequent entering of the prices into a computer. This research was conducted out of the Indiana and Ohio State

Research To Develop  
Methodology for  
Landsat, Using  
Satellite Data

Statistical Offices. Enumerators carry the "laptop" to the site, such as an auction barn, and enter the prices. The software is capable of allowing some editing to be done on the spot. The data can either be mailed into the office or transferred by modem over the phone.

In 1988, data from three satellite sensors (Landsat MSS, TM, and SPOT MSS) were compared for an eight-county area in western Kansas. Statistical analysis showed the Landsat TM data to be the best, at least for winter wheat. Similar data sets for areas in Iowa and Arkansas were collected and prepared to compare the sensors for corn, soybean, rice, and cotton estimation. Information gained from this research will be applied to entire State and region estimation for major crops in the early 1990's.

Major changes were made in 1988 to the PEDITOR software system for analysis of remotely sensed data. These changes took two general forms. First, changes were made in support of the above-mentioned comparisons of alternative satellite sensors. Before 1988, the PEDITOR system accepted only Landsat MSS data (which will not be available in the future). The second set of changes to PEDITOR involved moving the system from a mainframe computer to personal computers or supermicros. These changes make the system flexible with respect to satellite sensors and cost efficient for processing large volumes of data.

Reinterview  
Research on the  
Agricultural  
Survey

Reinterview research was expanded to six States for the December 1988 Agricultural Survey. This research is aimed at expanding statistical quality assurance procedures. Reinterviews allow measures to be made of variance and bias in responses and, in general, help to identify sources of error in the survey. This work will provide important information to the recently formed Agricultural Survey Quality team, which is charged with developing a formal quality control and management system for the Agricultural Surveys.

Rural Household  
Surveys

Basic analysis was conducted to assess the feasibility of using the agricultural-area sampling frame to survey all rural households in addition to farm households. The study indicated that the area frame is a viable sampling mechanism but that some design modifications would be necessary to survey rural populations efficiently.

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## ECONOMIC RESEARCH SERVICE

The Economic Research Service (ERS) is a U.S. Department of Agriculture agency established in 1961 principally under the authority of the Agricultural Marketing Act of 1946 (7 U.S.C. 1621-1627). The mission of ERS is "to provide economic and other social science information and analysis for improving the performance of agriculture and rural America."

ERS produces economic and other social science information as a service to the general public and to help Congress and the Administration develop, administer, and evaluate agricultural and rural policies and programs. The wide range of topics covered by ERS include:

- o U.S. and world agricultural production and demand for production resources, agricultural commodities, and food and fiber products
- o Costs of and returns to agricultural production and marketing
- o Economic performance of U.S. agricultural production and marketing
- o Effects of Government policies and programs on farmers, rural residents and communities, natural resources, and the public
- o Organization and institutions of U.S. and world agricultural production and marketing systems, natural resources, and rural communities

ERS-produced information is made available to the public through research monographs, situation and outlook reports, standardized data products in electronic media, professional and trade journals (including The Journal of Agricultural Economics Research), magazines (including Agricultural Outlook, Farmline, National Food Review, and Rural Development Perspectives), radio, television, newspapers, and frequent participation of ERS staff at various public forums.

ERS Provided Special Drought Evaluation	Special efforts by ERS kept Congress, the Administration, and the Interagency Drought Policy Committee current on the severity of last summer's drought and its likely impacts on crop yields, livestock production, farm income, and food prices. ERS provided an accurate assessment of the changing situation on a weekly basis and before results were available from more traditional survey programs.
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Ethanol's Prospects  
Evaluated

ERS research concluded that with the existing Federal fuel excise tax exemption, ethanol will likely remain cost competitive as a fuel-blending agent, especially given its value as an octane enhancer. Without the exemption and the likely agricultural and energy market conditions expected in years to come, ethanol may not be able to compete with many other fuel-blending agents.

Farm Credit  
Markets Examined

ERS economists examined rural and agricultural capital markets which continue to undergo pronounced changes. The effects of the Agricultural Credit Act of 1987, geographic deregulation of financial institutions, and severe regional problems in banking and thrift industries are still being felt. Rural and agricultural bank failures will continue to decrease, except in the Southwest, where delinquent oil and gas loans are a problem.

U.S.-Canada Trade  
Agreement Studied

ERS analysts calculated that Canadian producer subsidy equivalents (PSE's) were highest for dairy and sugar; moderate but growing for western grains and oilseeds; and low but stable for corn, soybeans, beef, and pork. Canadian support accounted for about a quarter of the value of agricultural production. The bilateral trade agreement could affect about half of the current U.S. agricultural exports to Canada and about a fourth of the U.S. imports from there. Most likely affected would be fresh fruits and vegetables, some oilseed products and grains, beef, wine, poultry, and eggs.

Foreign Farm and  
Trade Policies  
Analyzed

An ERS study concluded that for developed economies with large and productive agricultural sectors, dominant government policies are to protect the level and stability of farm incomes and assets and maintain the rural lifestyle. For developed economies with limited production and large import needs, the main policy goal is to protect farm incomes with high price supports through trade barriers. In most developing economies, a common policy objective is to become self-sufficient.

Trade  
Liberalization  
Studied

ERS analysts found that trade liberalization would lead to moderate increases in world prices and trade for most agricultural products. The increases would partly offset but not prevent the long-term decline in prices. Agricultural trade liberalization would have a modest effect in industrial countries.

Milk Order Program  
Studied

An ERS study determined that the Federal milk marketing order system could be modified to be more cost based and market oriented, thereby increasing economic efficiency while maintaining the public benefits of market stability. Producers in the Northwest, Mid-Atlantic, and Southwest would be the most disadvantaged, while fluid milk consumers in these regions would gain the greatest benefits. Producers in the Lake States, Southern Plains, and southern deficit regions would be the least disadvantaged.

Generic Certificate Costs Reviewed	Between April 1986 and March 1988, about \$17.9 billion of generic certificates were issued. Redemptions through May 1988 approached \$17.1 billion, of which \$12.4 billion (72 percent) was for corn, \$3.3 billion (20 percent) for wheat, and the remainder for other commodities under loan. An ERS analysis determined that while it may have cost more to issue certificates than make payments in cash during FY 1987, costs for FY 1988 and 1989 will have been about the same whether or not the payments had been in cash.
CRP Effects Listed	The Conservation Reserve Program (CRP), coupled with the existing Acreage Reduction Program and Paid Land Diversion, decreases crop supplies, reduces soil erosion, improves water quality, increases timber production, raises consumer food costs and farm income, and decreases commodity program expenses, according to an ERS assessment. The most important aspect of the CRP may be increased environmental benefits from targeting highly erodible lands.
CRP Water Quality Benefits Identified	The CRP will have an important impact on the quality of surface water in lakes and streams by removing from production some highly erodible cropland. ERS analysts anticipate increased participation in recreational fishing, and lower costs associated with dredging, reservoir sedimentation, roadside and irrigation ditch maintenance, water treatment, and flood damage. The removal of 23 million acres of highly erodible cropland will generate between \$1 billion and \$3 billion in water quality benefits.
Foreign Sales by Certain Counties Studied	ERS research revealed that the 419 rural counties that depend heavily on producing agricultural commodities for export benefited the most from trade upswings in the 1980's and suffered the most when exports declined. These counties are primarily in the Mississippi Delta, Corn Belt, and Great Plains, and half of their total farm sales were from five export-oriented crops--corn, wheat, soybeans, cotton, and rice.
Counties Tied to Farming Declined	ERS reported that farming provided at least 20 percent of total labor and proprietor income in slightly more than 500 counties during 1980-84, down from over 700 in 1975-79. These counties, mostly in the Great Plains and western Corn Belt, are not necessarily the largest producers; but farming represents a major economic base for them. They did not participate as fully as other counties in the diversification of the rural economy in the 1960's and 1970's.

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## AGRICULTURAL COOPERATIVE SERVICE

The Agricultural Cooperative Service (ACS) provides research, technical assistance, and information and education for the Nation's 5,109 farmer-owned cooperative businesses. The Agency is the information source within Government when issues of policy, legislation, or regulation concerning farmer cooperatives arise.

Volume of  
Agricultural  
Cooperative  
Business  
Up in 1987

The combined business volume of 5,109 agricultural cooperatives in 1987 was \$59.2 billion--up 1.3 percent. Net income was more than \$1,486 million, a 116-percent increase from the \$688 million in 1986 and the highest since 1980. The increase in business volume was due to increased marketing and related service volume. Farm supply volume was lower, reflecting decreased demand and lower prices of fertilizer and petroleum.

Financial  
Instruments  
of  
Cooperatives  
Studied

ACS completed a study of the wide range of financial instruments used by farmer cooperatives. The study was made under a cooperative research agreement with the University of Arkansas Law School. Included in the study were instruments used by non-cooperative-business corporations, such as stock certificates, as well as instruments unique to cooperatives, such as patronage refunds and per unit capital retains. Legal status with respect to rights and liabilities of the cooperative as issuer and the farmer-investor as owner and user of the cooperative was analyzed for each instrument.

Publications  
Analyze Co-op  
Imports,  
Exports

Foreign trade has become increasingly important to cooperatives, and two publications produced by ACS deal with the subject in detail. One reports on a survey of imports by agricultural cooperatives during 1986. A total of 28 cooperatives had imports valued at \$761.9 million, more than 83 percent of the imports being nonfood items such as farm supplies and petroleum. The other, published in 1988, is ACS' first comprehensive export directory. A total of 91 cooperatives were identified as significant exporters and, thus, relevant contacts for importers. All pertinent contact and product information and descriptions are provided.

Farm Women  
Involvement  
in  
Cooperatives

A study was made of Kentucky farm women's attitudes toward and involvement in farm supply and marketing cooperatives. The study of 880 farm women examined enterprise, family and personal characteristics of the boards of directors of 30 cooperatives, organizational procedures, and attitudes of administrators on women's involvement. Analysis of structural and personal factors associated with women's membership and participation provides valuable information to cooperatives trying to increase membership loyalty, involvement, and effectiveness.

Largest  
Cooperatives  
Strengthen  
Finances

In 1987, nearly all indicators gauging financial performance of the Nation's largest agricultural marketing and farm supply cooperatives pointed to improved operations and a stronger balance sheet. Several associations called 1987 a year of transition. A surge in exports plus a general strengthening of farm-sector economic conditions assisted in the cooperatives' turnaround. Although supply sales were off, total combined revenue of the top 100 rose nearly \$700 million (1.6 percent) to \$43.1 billion. Fruit and vegetable, dairy, and grain marketing cooperatives led the way with substantially increased sales. More significantly, these biggest U.S. cooperatives showed an impressive jump in net income (up 261 percent to \$717 million), with most commodity groups sharing in the brighter earnings picture. A sharp drop in losses (down 85.8 percent) proved the major factor in their bottom-line improvement. Assets increased in 1987 for the first time in 6 years, reaching \$15.9 billion. Growth in assets, combined with the continuing decline in total borrowed capital, significantly improved the financial status of the largest U.S. cooperatives.

How Farmers  
Use  
Cooperatives

The major finding of a study on farmers' use of cooperatives was that the buying and selling behavior of farmers does not vary greatly by size or type of farm. However, some differences in types and sizes of farms provide the basis for better service to farmers and increased patronage.

Technical  
Assistance  
Education

In 1988, ACS was involved in 77 formal, technical-assistance projects, with 103 cooperatives and producer groups as participants. Twenty-seven projects involved emerging and developing cooperatives and producer groups representing more than 1,000 members. Fifty projects were carried out on behalf of established cooperatives. A number of these projects involved studies on merger feasibility, cost, marketing alternatives, and alternatives to traditional row crops. ACS entered the new fiscal year with 42 active technical-assistance projects under way.

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## ANIMAL AND PLANT HEALTH INSPECTION SERVICE

The Animal and Plant Health Inspection Service (APHIS) conducts research and methods development on animal damage control (ADC) through its Denver Wildlife Research Center (DWRC) at Denver, CO. The research is aimed at developing new knowledge necessary to combat vertebrate pests that destroy America's agricultural production. Knowledge and tools resulting from this research are used to reduce wildlife conflicts with agriculture. DWRC works to transfer existing technology to broader uses in control of animal damage. DWRC also collects scientific information on new chemical registrations and for maintenance of existing registrations with the Environmental Protection Agency.

### Baiting Research for Coyote Control

Use of baits for selective coyote control potentially offers an inexpensive means of reducing predation on sheep and other livestock. Field and pen studies to determine coyote acceptance of small baits have been conducted in Idaho and Utah. Physical and physiological marking agents were incorporated into baits to simulate the use of toxicants or other chemicals in the field. Bait placement and bait density variables are being studied by recovering scats and by analyzing coyote blood to determine the proportions of local populations that consumed baits. Recently, marking trials indicated that up to 83 percent of the coyotes consumed small baits in field applications, but results were highly variable. Current work seeks ways to reliably deliver baits to a higher percentage of local coyote groups throughout the year.

### M-44 Cyanide Ejector for Coyote Control

An M-44 is a mechanical, spring-powered device designed to propel a measured amount of sodium cyanide in a plastic capsule into the mouth of a coyote. A series of research studies was undertaken to improve M-44 ejectors and capsules. Field work has been completed on a study to compare lubrication treatments that reduce device malfunctions due to corrosion. Another study was begun to evaluate prototype transparent plastic capsules that would allow easier inspection of the condition of the cyanide so that caked or defective capsules could be rejected before use. Improved capsule-sealing materials have been identified for the currently used polyethylene capsules.

### Evaluation of Reregistration of Agricultural Rodenticides

A field trial was conducted in south-central Washington to determine efficacy of strychnine-containing oat-groat baits on northern pocket gophers in coniferous forest habitats. Three experimental strychnine bait concentrations (0.75, 1.10, and 1.25 percent) were field tested against the standard 0.5-percent strychnine oat bait registered for controlling pocket gophers. The 0.5-percent bait was 92 percent effective. Each of the higher bait concentrations was 100 percent effective. These

results and other field data strongly suggest that 0.5-, 0.75-, and 1.00-percent baits should be evaluated under operational baiting conditions for final field efficacy determination.

Food Flavoring Developed as a Bird Repellent

Flavor chemicals that are selectively repellent to birds may provide cost effective control methods with relatively low environmental hazard. One group of such candidate repellents are anthranilate derivatives. The bird repellency of livestock feed treated with dimethyl anthranilate (DMA) was evaluated at five feedlots in Kentucky. Results indicated that the 1.0-percent DMA concentrate was effective in reducing losses due to starlings. In a field test conducted in New Jersey, both DMA and methyl anthranilate (MA) showed promise in reducing grazing of landscaped areas and golf courses by Canada geese. Both compounds were applied as a liquid spray formulation to the experimental turf areas. Results of the tests indicated that MA would be more cost effective than DMA as a bird repellent.

Mimicry Theory Applied To Improve Bird Repellent Performance

A common theory in the field of animal behavior is that animals may learn to avoid prey items by associating them with similar prey items that prompt specific aversion responses. This theory would predict that treatment of only a proportion of rice seed with a taste aversion chemical could be as effective in reducing blackbird feeding as treatment of all of the seed. In a flight pen study, small flocks of red-winged blackbirds were allowed to forage on plots sown with rice, varying percentages of which (0, 50, and 100 percent) had been treated with 0.125 percent methiocarb, a proven bird repellent. Results indicated that in the plots with the 50- and 100-percent treatments, feeding on rice seed was nearly eliminated. If confirmed in field tests, these results could lead to a reduction in the total amount of chemicals needed to discourage pest activity.

Stupefaction Evaluated as a Technique for Capturing Nuisance Birds

Local populations of several species of gulls and waterfowl are often responsible for nuisance, safety, and agricultural problems. A potentially safe and effective method for reducing such problems is to bait the birds using bread treated with alphachloralose (AC), a stupefactant that is registered as a bird control chemical in several countries outside the United States. Affected birds then could be collected and removed from the site. Initial field trials in Ohio on both herring gulls and Canada geese indicated that AC can be effectively used.

Assessment Techniques Developed for Bird Roost Toxicants

Large congregations of roosting blackbirds cause nuisance, safety, health, or agricultural problems. In anticipation of conducting field tests of an aerially applied lethal roost toxicant for selectively reducing blackbird roost, three simulated (nontoxic) roost-treatment tests were conducted to evaluate and refine field techniques for assessing efficacy, environmental fate, and nontarget hazards. The field tests,

conducted in Arkansas and North Dakota, will help assure that the techniques used in developing a candidate roost toxicant will be both efficient and accurate.

New Research  
Program on Bird  
Damage to  
Aquaculture

The aquaculture industry has undergone tremendous growth in recent years. With this growth has come problems associated with fish-eating birds. These problems are particularly acute in the Delta States, where cormorants, herons, and various other species are having a negative impact on production of catfish and other commercially important fish. In response to the need for developing cost effective and environmentally acceptable control methods for reducing these losses, a research project was established in August 1988 on the campus of Mississippi State University in Starkville, MS.

Insect Secretions  
Tested as Bird  
Repellents

Many insect species have developed chemical defenses against predation by birds. These chemical defenses may represent new bird repellents for protecting agricultural crops. The azalea lace bug nymph, which is commonly avoided by birds, secretes an offensive substance that may be responsible for the birds' avoidance behavior. In cage experiments, green peach aphids, which are not avoided by birds, were treated with a mixture of the principal components of the lace bug secretions. The treated insects were consistently avoided by red-winged blackbirds in these trials. Similar experiments are planned with other lace bug species that may possess chemical, antipredator defenses.

Evaluation and  
Registration of a  
Candidate Roost  
Toxicant

CPT (candidate roost toxicant) has been proposed as a potential toxicant for blackbird and starling roosts to supplement PA-14, a surfactant roost toxicant developed and registered by the ADC research program. PA-14 use is restricted by weather conditions. The registration of CPT would allow treatments to occur throughout the year and throughout the United States. The DWRC has conducted a number of laboratory tests and limited field trials. However, additional trials are necessary to complete the evaluation of the efficiency potential and hazards of this candidate toxicant.

Reregistration of  
Strychnine as a  
Vertebrate  
Pesticide

The APHIS ADC (animal damage control) program has 13 registrations for vertebrate pesticides containing strychnine. In December 1987, the EPA issued Data Call-In, which requires all strychnine registrants to provide laboratory and field data to support continued registration of their uses. As a result, ADC has conducted a number of studies to generate data on efficacy of strychnine baits, environmental fate, toxicology, and hazards.

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## HUMAN NUTRITION INFORMATION SERVICE

The Human Nutrition Information Service (HNIS) develops, through applied research, information required to improve public understanding of the nutritive value of foods, the nutritional adequacy of food supplies and diets, and the selection of nutritious and healthful diets. The Agency compiles information on food composition; monitors food and nutrient consumption by U.S. households and individuals; measures consumer awareness, understanding, and attitudes about diet and health relationships and dietary guidelines through national surveys; and develops materials and techniques to help Americans improve their nutrition and reduce the risk of disease through better diets.

Decennial Food Consumption Survey Completed

Data collection for the 1987-88 Nationwide Food Consumption Survey (NFCS) initiated in April 1987 was completed in August 1988. This survey, conducted at approximately 10-year intervals since 1935, is the sixth decennial survey conducted by USDA to monitor food consumption and dietary practices by households and individuals. Data analysis is under way to report the results of NFCS' 1987-88 target sample of 6,000 all-income and 3,600 low-income households and the individuals residing in the households.

Continuous Monitoring of Dietary Intakes by Individuals

Completion of the 1985 and 1986 Continuing Surveys of Food Intakes by Individuals (CSFII) marks the successful implementation of the first annual nationwide dietary survey to monitor changes in dietary habits. All nine reports for the 1985 and 1986 CSFII were published within 18 months after completion of annual data collections. The CSFII was initiated to help assess the dietary status of the U.S. population between the larger decennial NFCS.

Plans are under way to conduct CSFII each year from 1989 through 1996. Data collection for 1989 CSFII began in April 1989. The survey includes two samples--a sample of individuals in 1,500 all-income households and a sample of individuals in 750 low-income households. An important aspect of this survey, and of all USDA dietary surveys, is the collection of 3 days of dietary data, which account for day-to-day variations in food intakes. The 1989-96 CSFII differs in several ways from the 1985 and 1986 surveys. It will include all sex/age groups, whereas the 1985 and 1986 surveys included only women and men 19 to 50 years old and children 1 to 5 years old. It has been designed to accommodate modules from other Federal agencies with concerns relative to nutrition monitoring. In 1989, the Continuing Survey will include a module planned cooperatively with the Food and Drug Administration and USDA's Food Safety and Inspection Service on consumer knowledge and attitudes on diet, health, and food safety issues. This endeavor represents the

first time that a nationwide sample will be used to study the relationship between individuals' actual dietary intake and their knowledge and attitudes about foods, nutrition, and food safety.

National Nutrition Monitoring System (NNMS)

Planning for the NFCS 1987-88 and the 1989 CSFII was coordinated with the Department of Health and Human Services' (DHHS) National Health and Nutrition Examination Survey (NHANES) III (which is to begin in 1989) to make appropriate questions, procedures, and data base compatible. A joint HNIS/National Center for Health Statistics (NCHS) Nutrition Monitoring Coordination Committee meets regularly to maintain coordination. As of 1987, NFCS and NHANES will use a common nutrient data base developed and maintained by HNIS. A joint HNIS/NCHS Nutrient Data Base Committee was formed and meets regularly to ensure continued development of compatible systems for handling and coding nutrient data for dietary intake surveys.

Work is under way for the second report to Congress on the NNMS scheduled for 1989 through a joint USDA/DHHS contract with the Life Sciences Research Office (LSRO) of the Federation of American Societies for Experimental Biology (FASEB). An ad hoc Expert Panel on Nutrition Monitoring, selected by LSRO and composed of persons outside the Government who represent a variety of disciplines, are developing the report. It will include a reassessment of iron nutriture and an update on the dietary and nutritional status of the U.S. population based on data from the NNMS produced or released since publication of the 1986 report and an indepth analysis on nutritional factors in cardiovascular disease.

Data on Nutrient Content of Fast Foods Issued

The section "Fast Foods" (AH 8-21) in Agriculture Handbook No. 8, "Composition of Foods," was published. This section includes the nutrient data for over 150 fast foods and related products, primarily in ready-to-eat form as served by fast-food establishments.

HNIS publishes provisional tables on food components for a selected number of frequently consumed foods of special interest to nutrition and other health professionals as reliable data become available. Two provisional tables were published in 1988--one on the total dietary fiber values for about 300 frequently consumed foods and one on the content of stearic acid, total fat, and other fatty acids in selected foods.

Cost of Food at Home Published

The cost of four USDA family food plans--thrifty, low-cost, moderate-cost, and liberal--was released monthly. The thrifty food plan is used as the basis for benefits in the Food Stamp Program.

Impact of Dietary Guidelines for Americans

The national dissemination and impact of the Dietary Guidelines for Americans, jointly issued by USDA and DHHS, were studied through a cooperative research project conducted by researchers at the University of Wisconsin. Almost 500 professionals and nutrition education practitioners representing various national, State, and community gatekeepers in the communication and distribution process were interviewed by telephone. Results provide evidence of widespread adoption and acceptance of the Dietary Guidelines, as well as the significant role of these individuals representing various groups in multiplying the penetration and impact of the Dietary Guidelines. Many of those interviewed emphasized the importance of experts in the areas of health and nutrition continuing to "speak with one voice" in identifying important dietary guidance messages.

Dietary Guidelines Review

Based on the intent of USDA and DHHS that current research findings be periodically reviewed and interpreted so that the best, most up-to-date advice can be given to the American public, a new Federal dietary guidelines advisory committee will be established. A notice of invitation for nominations to a dietary guidelines advisory committee was published in the "Federal Register" in the fall of 1988. A nine-member committee will be jointly appointed by the USDA and DHHS to determine if revision of the Dietary Guidelines for Americans is warranted based on advances in scientific knowledge and if such a revision is warranted to advise the Secretaries regarding any recommended revision to the guidelines.

Dietary Guidelines Promoted

The Dietary Guidelines were promoted to reach special audiences. "Cooking for People with Food Allergies" was published, and it contains information on food selection and preparation for people who must omit wheat, milk, eggs, or corn from their diets because of allergy or intolerance. The recipes follow the principles of the Dietary Guidelines for Americans.

Four new bulletins were developed to show how the Dietary Guidelines may be used in specific food-related activities--preparing foods and planning menus, making bag lunches and snacks and desserts, shopping for food and making meals in minutes, and eating better when eating out. The bulletins are designed in a magazine-style format with color photography, illustrations, charts, and recipes. A consumer marketing firm was employed to develop the design and to evaluate the bulletins through qualitative methods such as focus-group and open-ended interviews. A Dietary Guidelines poster featuring an attractive full-color food wheel is being developed for enclosure in the home economics magazine Forecast and for sale to the public. Release of the bulletins and poster was planned for early 1989.

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#### AGRICULTURAL MARKETING SERVICE

Market research and development in the Agricultural Marketing Service (AMS) help to minimize the cost spread between agricultural producers and consumers by finding new ways to increase food-marketing efficiency. The Agency's research encompasses three main efforts: (1) planning wholesale food distribution centers and farmers' markets to address specific facility problems hampering food marketing, (2) estimating the market potential for new or expanded production of agricultural products to open additional sources of income for producers, and (3) conducting method-improvement studies to increase the efficiency of specific, food wholesaling and processing activities. The Agency also maintains a matching funds program with State departments of agriculture to conduct marketing studies.

#### Impact of a Wholesale Food Center Documented

As a sequel to the major feasibility study preceding construction of the Maryland Food Center, (a 400-acre wholesale food distribution center between Baltimore, MD, and Washington, DC), researchers documented the operations of produce firms now located at the Center. They found that since moving to the Center, these firms broadened market areas, increased annual sales, improved operating efficiencies, augmented regional food industry employment, and lowered costs to buyers through increased competition. Overall operating costs per ton of product handled by all regional produce firms dropped over \$12 per ton of product handled. Firms at the Center incurred operating costs of \$32 per ton less than firms located elsewhere in the region. Costs were adjusted for inflation.

#### Farmers' Market Developments Offers New Opportunities

Researchers have completed detailed studies for new combined wholesale/retail farmers' markets in upstate South Carolina and Tupelo, MS. Published findings indicate that the construction of new produce marketing facilities in the "Big Ten" area of Mississippi may contribute substantially to augmenting low farm income by providing additional marketing facilities to encourage commercial fruit and vegetable production. Similarly, expansion of the existing Greenville, SC, farmers' market can provide additional marketing opportunities to area agricultural producers and encourage increases in fruit and vegetable production. Other studies are underway in Benton Harbor, MI, and Georgia.

#### Food Center Expansion Planning

Studies on long-term expansion planning are under way at major food distribution centers in New York, NY, and Baltimore, MD. These studies are being conducted in cooperation with the governing authorities and management. Both studies indicate that additional expansion is necessary to accommodate regional food distribution facility requirements and that some of the

expansion efforts will require the acquisition of additional land beyond the original sites. In both instances, planning is directed to accommodate additional organized markets supporting meat and related products and other types of food wholesale and processing firms. These expanded markets will be major elements in the efficient distribution of food through two of the largest population areas in the United States.

**Revitalization of Marketing Facilities for Syracuse, New York**

Plans for a new 250,000-square-foot wholesale food center and farmers' market in Syracuse, NY, offer an opportunity to revitalize the Central New York Regional Market. This 50-year-old market is a major center for food wholesaling and processing in the area as well for direct sales between farmers, consumers, and wholesalers. Modern buildings and new support facilities will allow this important market to improve its service to the area. Preconstruction planning is now under way for the new center.

**Market Modernization Extends Useful Life of Existing Food Centers**

Many older food centers are experiencing severe crowding due to rapidly expanding sales and are hampered by building designs that are no longer suitable for modern operations. A series of engineering studies in existing food centers have developed methods of altering existing market buildings to accommodate additional product volume while also accommodating modern warehousing and handling technology. Expansion and modernization are an attractive alternative to the major investments required for constructing new markets. Major studies have been recently completed in Boston, MA, and Columbia, SC.

**Modern Building Designs Improve Operating Efficiency and Minimize Construction Costs**

Preliminary results of a detailed study of building technology suitable for food centers have indicated that substantial potential savings are possible in initial building investment requirements through innovative design and careful arrangement of support facilities.

**Food Centers' Importance to Agriculture**

Research has indicated that wholesale food distribution centers along the east coast of the United States are important customers of Florida fruit and vegetable growers. Of the trucks carrying produce and ornamentals from Florida to the Northeast, 36 percent deliver products to major food centers. Similarly, of vehicles leaving Florida for southern destinations, 21 percent unload at regional wholesale food centers or produce markets.

**Vegetable Marketing**

Market development research conducted in cooperation with the Horticultural Producers Federation (HPF) to help 14 small-farmer cooperatives in the Southeast compete in the wholesale vegetable market continued this year with the implementation of centralized marketing. Seven of the cooperatives participated

#### Alternative Marketing Opportunities

in marketing 164,244 boxes of 8 vegetables under the HPF label, and the customers and farmers were generally pleased with the quality of HPF's marketing methods. The volume was about half that anticipated due to the poor weather conditions. This year, HPF plans to concentrate on only two or three commodities.

#### Disinfestation Methods for Florida To Export Grapefruit to Japan

The research project on disinfecting Florida grapefruit bound for Japan has been completed, and the draft manuscript on the project has been written and is being edited. The project deals with the facility and cost requirements for disinfecting grapefruit by each of three alternative methods: irradiation of fruit, establishment of fly-free zones, and use of cold treatments. Fixed and variable costs for the alternatives are presented along with facility designs.

#### Damage to Dry Grocery Products in Warehouses

A study was made to identify the causes of damages to dry grocery products in warehouses, ascertain differences in damages caused by conventional and mechanical operations, identify the actions that may be taken to control damage, and explain how damaged goods are recouped and/or disposed of. The study is now complete and a manuscript has been published. The cost of damage is estimated at \$30 million annually.

#### Development of Standard UPC/PLU Coding System for Produce

The objectives in the development of a standard UPC/PLU coding system for produce are (1) to apply generic uniform product codes (UPC's) to all packages of fixed-weight produce, (2) to standardize all price look-up numbers (PLC) for produce throughout the United States and, (3) to standardize item numbers for all variable-weight packages of produce. The Marketing Research Branch represents USDA on the Perishable UPC Random Weight Ad Hoc Committee. A list of fixed-weight produce items has been developed, and standardized codes have been assigned to them. Work is in progress on objectives 2 and 3.

Evaluation of Harvesting and Handling Methods, and Marketing Potential for Fresh Broccoli

The objectives of an evaluation study for broccoli are (1) to determine costs of various methods for harvesting, handling, and transporting fresh broccoli and (2) to identify the lowest cost marketing system without compromising quality. Secondary data on broccoli production and marketing in Georgia and South Carolina have been collected through a cooperative agreement with the University of Georgia.

Shiitake Mushroom Marketing

As a result of numerous requests for information from small producers of shiitake mushrooms, AMS personnel responded with both research and technical assistance. The research assessed the size of the U.S. shiitake market and determined the expected rate of growth. Investigations have been started to develop strategies enabling small producers to market their products. Several presentations have been made to industry groups, and assistance is being provided in analyzing consumer demand. A product-packing and test-marketing project was conducted in southeastern Virginia in cooperation with Virginia Polytechnic Institute and State University (VPI) and Farm Fresh stores.

Feasibility of Alfalfa Cubing Plant

Southwest Iowa is the study area for analyzing the economics of constructing and operating an alfalfa cubing plant in cooperation with the Golden Hills Resource, Conservation and Development Council; Southwestern Iowa Hay Growers Association; and Iowa State University. A decline in the cattle industry and other factors have resulted in a surplus of hay in the area. This analysis will now focus on the market potential for hay cubes and the costs and benefits to farmers in the region. A preliminary market analysis was presented in December 1987. The part of the analysis concerning facility and equipment requirements, plant layouts, and feasibility was presented in March 1988. When complete, the entire analysis will be published for use by groups in other areas of the country.

Farmers' Assembly Market in Northern Kentucky

A study has been started to analyze the feasibility of establishing an agricultural products market in northern Kentucky, as part of a new farmers' market, with facilities for assembling, washing, cooling, grading, and packaging fresh vegetables. The study includes the feasibility of establishing both wholesale and retail outlets featuring food products, nursery stock, garden supplies, crafts, and support businesses. The study is a cooperative effort with the Northern Kentucky Area Development District, the Kentucky Department of Agriculture, and the Extension Service.

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## OFFICE OF TRANSPORTATION

The Office of Transportation (OT) helps ensure that an efficient and equitable transportation system serves the needs of agriculture and rural America. This is accomplished through research on specific transportation problems, analysis of agricultural impacts of policy changes and proposed changes, and informational assistance to shippers and carriers of agricultural commodities.

### Railcar Shortages for Grain Shippers

During the winter and spring of 1988, staff members monitored and studied the impact of railcar shortages experienced by grain shippers across the United States. Throughout the shortage period, Agency staff kept in contact with shippers, railroads, and receivers, monitoring the scope and severity of the problem and its impact on local shippers. A report entitled "Railcar Shortages for Grain Shippers: A Current Overview" provided timely and detailed information on the capacity of the U.S. grain car fleet, the types of cars currently in grain service, the demand for rail transportation of grain, and the magnitude of shortages in selected areas. As a followup, staff members interviewed grain shippers in 17 States to assess the impact of car shortages on their operations and to learn of their expectations about future railcar supply problems.

### ICC Agricultural Transportation Filings

OT participated in three regulatory proceedings before the Interstate Commerce Commission (ICC) on behalf of U.S. agriculture in 1988. Significant proceedings included (1) Shippers Committee, OT-5, v. The Ann Arbor Railroad Company, where a supplemental pleading urged the ICC to quickly resolve the controversy surrounding access of private, covered-hopper grain cars to the national rail system and (2) National Grain and Feed Association v. Burlington Northern Railroad, where the ICC was asked to allow OT intervention in a proceeding in which the lawfulness of the Burlington Northern Railroad's Certificate of Transportation program had been challenged. Staff members also monitored regulatory proceedings before the ICC on a daily basis for issues affecting the interests of agriculture and rural America.

### Inland Waterways User's Board and Agriculture

The Water Resources Development Act of 1986 established a user's board composed of 11 members appointed by the Secretary of the Army to represent various regions of the country and various commodities shipped on the inland waterways. In addition, the Act provided for three official observers to be designated by the Secretaries of Agriculture, Transportation, and Commerce. The OT Administrator serves as official observer for USDA. The user's board meets semiannually to develop and make recommendations regarding construction, rehabilitation priorities, and spending levels on the commercial navigation

features and components of the inland harbors and waterways of the United States.

Safe Pesticide Transportation

In cooperation with Southern States Cooperative, Inc., OT produced a video, "Be Prepared--Just In Case," on the transportation of pesticides from the supply store to the farm. Aimed at farmers, pesticide applicators, farm supply store employees, and rural firefighters, this safety video illustrates how quickly an accident involving the transport of pesticides can happen to even the most cautious driver. It provides helpful guidelines to prevent such accidents. The video is being used in the Environmental Protection Agency's certification program for pesticide applicators. Staff members also began work on a brochure to provide farmers with safety guidelines and a checklist to prevent toxic spills on highways.

Cattle Handling and Transport Video

OT produced a video on cattle handling and transport in conjunction with the Livestock Conservation Institute. The video--the first of its kind available for the livestock industry in the United States--instructs animal handlers in feedlots, truckers, stockyard employees, and farmers on how to move cattle humanely from one location to another.

Handbook on Refrigerated Trucking

In response to interest from the trucking industry, OT revised and reissued the handbook "Protecting Perishable Foods During Transport by Truck." This handbook provides information on the recommended handling and environmental requirements for over 100 food products. Since its original release by USDA in 1956, demand for the handbook from the trucking industry has remained high.

Far East Port Survey

OT completed a report outlining constraints to U.S. agricultural exports arriving at Pacific Rim ports. The report was prepared by a team that visited 15 ports in China, Japan, Korea, the Philippines, and Taiwan. In addition to the many food import and maritime policies that discriminate against U.S. products and carriers, the study found that some of the major constraints were inadequate facilities and obsolete or poorly maintained equipment. USDA's Foreign Agricultural Service Trade Mission to the Philippines used the report in developing strategies to relieve the constraints on U.S. agricultural exports. Agricultural exporters also benefited from information on port facility and inland transportation systems when planning foreign sales.

Double-Stack Rail User's Guide Update

To help agricultural exporters, staff members began updating a fact sheet on double-stack container trains. The fact sheet contains a listing of current double-stack services and appropriate contacts throughout the United States. OT continued to monitor the growth and advancements made by

double-stack rail services in the United States. In one year, double-stack movements increased from 58 to 93 trains per week. Transit times decreased, and the decrease resulted in improved equipment utilization and reduced carrier operating costs. While agricultural exporters used westbound stack movements to ship products to the Far East, service improvements led to increased movement of perishables domestically from central California and the Pacific Northwest.

Agreement on the  
Transport of  
Perishables

The United States is a signatory to a United Nations Economic Commission for Europe (ECE) treaty entitled "Agreement on the International Carriage of Perishable Foodstuffs and on the Special Equipment Used for Such Carriage" (ATP). The authority to implement ATP has been delegated to OT. During the past year, OT continued working with the State Department in defending U.S. rights and interests under ATP. Staff members drafted an objection to an amendment proposed by Italy that could have forced the United States to apply the Agreement to carriage between the United States, Mexico, and Canada; and they successfully defended the U.S. position at a meeting among the countries that are parties to the Agreement.

Implementing the ATP program also involved certifying, upon request, refrigerated trailers and containers for sale and service in ECE countries, as well as representing the United States at meetings to discuss proposed amendments. In cooperation with other Government agencies and private industry, OT studied such proposals and their possible implementation to ensure that any changes to the ATP are consistent with U.S. interests and do not hamper trade in agricultural products.

Mexican Border  
Transportation  
Coordination

Logistical coordination of agricultural trade between the United States and Mexico began in the late 1970's, when the volume of trade increased significantly, particularly in regard to rail shipments of U.S. grain into Mexico. Because of the resulting logistical problems, CONASUPO (the food-purchasing agency of the Mexican government) and USDA agreed to establish a bilateral transportation group to meet once or twice a year, and to appoint coordinators to handle ongoing logistical problems. The USDA border coordinator is an OT staff member.

OT sponsored a meeting of this bilateral transportation group in San Diego, CA, in May 1988. It was attended by over 300 representatives of grain merchandisers, grain importers and purchasers, rail carriers, and Government agencies interested in increasing the efficiency of cross-border interchange. The USDA border coordinator also was involved daily with border transportation problems relating to inspection, customs, or border interchange of U.S. agricultural exports to Mexico.

Workshop on the  
Shipping Act of  
1984

In May 1988, OT with Fresno State University jointly conducted a workshop for agricultural exporters to discuss the Shipping Act of 1984. This act governs most of the procedures used by steamship conferences to establish rates, set tariff rules, and provide services to exporters. The act is currently under review by the Federal Maritime Commission, and will be reviewed by Congress in 1989. The workshop focused on discussing current ocean shipping issues and on finding ways for agriculture to be involved in the Shipping Act review. A wide range of commodity groups were represented, including the citrus, raisin, cotton, and lumber industries and large and small shippers of beef, rice, wine, nuts, hay, and assorted vegetables.

Rural Bridge  
Activities

During 1988, OT helped plan timber bridge conferences to be held in West Virginia and Wisconsin. In cooperation with the National Forest Products Association, OT staff members coordinated the development of a timber bridge brochure for rural officials called "Modern Timber Bridges: A Viable Alternative for Rural America." They also continued working with the Forest Service on a technology transfer plan for timber bridges. The plan includes the development and dissemination of timber bridge information and the conduct of onsite demonstrations. OT also was relied upon to develop and disseminate information about rural bridges based upon the "National Bridge Inventory," supplying national and State statistics to the National Association of Counties, the American Farm Bureau Federation, USDA's Forest Service, and others.

Rural Rail

As needed, OT has routinely provided technical assistance to rural communities and State and local governments interested in options available to maintain local rail service. In 1988, to integrate information on rural rail assistance from a number of sources, OT prepared a handbook entitled "Maintaining Local Rail Service." The handbook summarizes rail regulations as they apply to railroad abandonment, methods for contesting abandonment, alternatives to abandonment, information for nonrailroad buyers of local, low-density rail lines, and available rural-rail-assistance programs at both the Federal and State levels.

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## OFFICE OF INTERNATIONAL COOPERATION AND DEVELOPMENT

The mission of the Office of International Cooperation and Development (OICD) is to coordinate and conduct the Department's international programs in agriculture and related fields.

International research and education programs include scientific and technical exchanges, administration of collaborative research, representation of USDA and U.S. Government research and educational interests in international organizations, and training and facilitation of private sector involvement in agricultural development and cooperation. Programs are conducted cooperatively with other USDA and U.S. Government agencies, universities, and the private sector.

### Wheat Improvement Using Bio-technologies With Spain

By cooperating on recombinant DNA methods in cereal grains, Spanish scientists and California researchers at USDA's ARS are defining wheat gene structure, organization, and expression. They are using biotechnologies to introduce new or alien DNA into the wheat genome, thereby improving wheat quality and developing a better understanding of the molecular basis of wheat quality.

### Collaboration With Zimbabwe on a New Industrial Crop

Howard University scientists are collaborating with Zimbabwe on research to utilize Vernonia galamensis, a potentially valuable oilseed crop. The seed of the indigenous African species of Vernonia galamensis is rich in an oil of unique composition and physical properties. Because of its properties, the oil could have practical applications in the manufacture of adhesives, plasticizers, industrial coatings, varnishes, and paints, without competing against other domestic crops. Meal from the seed may also be useful as an ingredient in livestock feed.

Research on vernonia oil at Howard University first focused on pilot-scale extraction and refining, and use of the refined oil in developing methods to synthesize industrial chemicals, particularly dibasic acids used in the nylon and plastic industries. The defatted meal, which is left after the oil is extracted from vernonia seed, is being examined for its amino acid profile and will be assessed for use as an animal feedstuff.

### Biological Agents To Control Gypsy Moths Exchanged With India

In a recently completed long-term research project in India, several new biological agents were found which offer the potential to control the gypsy moth in North America. The exchange of germplasm of beneficial wasps, nematodes, and fungi between Indian and USDA/ARS scientists in Delaware was an important product of this project.

Controlling  
Stored-Product  
Insects With  
Israel

USDA scientists in Georgia collaborated on a U.S.-Israel Binational Agricultural Research and Development Fund (BARD) project to use modified atmosphere storage as an economical and effective alternative to the use of chemical fumigants to control six, major grain-storage insects. As a result of this research, modified atmospheres to control grain-storage insects have been successfully applied and are already used commercially. Further research concerns extending the variety of crops to which the technology can be applied.

Cochran Fellows  
Program

Since 1984, the U.S. Congress has funded the training of agriculturalists from countries which do not receive assistance through the Agency for International Development (AID). Training opportunities are for senior and midlevel specialists and administrators representing the public and private sectors and concerned with agricultural trade, management, and marketing. During FY '88, more than 300 Cochran Fellows were selected for this program.

Malawi  
Agricultural  
Research and  
Extension  
Project

Under a Malawi Agricultural Research and Extension project, more than 50 Malawians are pursuing degrees at U.S. universities. During the summer of 1988, OICD staff collaborated with Malawian Ministry of Agriculture officials to convene a 2-week seminar in Washington for the Malawian students. More than 50 students were brought in from 21 different universities across the United States to share their experiences in a structured format. The students were able to discuss their programs of study with their own Ministry officials, thus enhancing the relevancy of their educational experience for both themselves and their employers.

International  
Water Quality  
Modeling  
Symposium  
Conducted

The Office of International Cooperation and Development, Scientific and Technical Cooperation Division (OICD/STC), in coordination with the International Science and Education Council (ISEC) organized an international symposium on water quality modeling of nonpoint agricultural sources in Logan, UT, in June 1988. The conference brought together about 150 experts from 15 countries and over 30 States to address the critical need for developing better models to help water managers and farmers make decisions about uses of agricultural chemicals.

The symposium was very successful in providing a forum for an international dialogue between developers of models and users of models. A state-of-the-art text on water quality modeling will be published in late 1988 or early 1989 based on the symposium presentations.

The water quality modeling symposium is the second major symposium which OICD/STC has helped organize. The first, which focused on Africanized bees and bee mites, was held in April

1987 at Ohio State University. Another international symposium organized by OICD in coordination with ISEC was "Planning for Agroforestry." This symposium was held at Washington State University, in Pullman, WA, April 23-27, 1989. It provided a forum for developing methods that can be used to implement agroforestry systems, and for identifying successful strategies, useful in subsistence and commercial settings in both developed and developing countries. Approximately 146 participants, representing 26 countries, attended the symposium. Other sponsors included the Forest Service, the Soil Conservation Service, and the Extension Service. OICD/STC plans to continue organizing international symposia on topics of particular interest to the U.S. agricultural community. Symposia on sweet potato planting and meat, dairy, and hair goat production are planned for FY '90 and FY '91.

Control of  
Southern Pine  
Beetle With  
Biological Agents  
From Mexico

In 1987 and 1988, OICD funded two exchanges to Mexico to identify biological agents that could be imported to control the southern pine beetle (SPB), a serious pest of North American coniferous forests. As a result, scientists from the USDA Forest Service believe that Mexico shows promise of being a rich source of SPB biological control agents. The complex of insect enemies of allied species from which candidate insects have been collected and evaluated is available only in Mexico.

While the southern pine beetle may play a significant role in natural southern pine forest succession, intermittent epidemics disrupt the stability of the managed southern pine ecosystem, the economy of the area, and the industries that are based on the growth and production of southern pines. Direct and indirect losses result from SPB outbreaks. From 1960 to 1980, this insect killed trees equivalent to 2.5 billion boards and 8.5 million cords of pine, and only half the volume was salvaged. Losses from 1971 through 1980 were estimated at \$345 million.

U.S.-Soviet  
Agricultural  
Cooperation  
Expanded

The two U.S.-U.S.S.R. working groups (Agricultural Research and Technological Developments and Agricultural Economic Research and Information) under USDA's bilateral Agreement on Cooperation in the Field of Agriculture met in Washington, DC, September 9-11, 1987, to select and recommend to the U.S.-U.S.S.R. joint committee a set of exchange activities for 1988 and 1989. The recommended program calls for the exchange of 16 U.S. and 15 Soviet teams, agricultural information and data, germplasm, and biological pest control organisms. When the joint committee met in Washington, DC, January 25-26, 1988, the working groups' recommendations were formally accepted. Thus far, in 1988, three U.S. teams have visited the Soviet Union, all three having highly successful and beneficial exchanges.

International  
Science and  
Education Council

The first team studied recent developments in the Soviet feed-livestock economy and were thus provided an opportunity to assess the impact of Soviet President Mikhail Gorbachev's economic reforms on the efficiency of this sector, especially consumer satisfaction with domestic meat and milk production. Investigating the possibility of exporting U.S. grain and protein meal to the Soviets to increase both the quality and quantity of outputs was also a priority for the team. The second U.S. team was made up of members of the USDA Forest Service, which studied both reforestation efforts and biological control of the gypsy moth, a dangerous forest pest.

The International Science and Education Council (ISEC) brings together representatives of USDA agencies and the land grant and State universities (NASULGC and AASCU) to encourage collaborative efforts in international agriculture in areas of mutual interest. In 1988, ISEC sponsored three notable activities.

ISEC, through the efforts of its Scientific and Technical Cooperation Committee, sponsored an international symposium on water quality modeling of nonpoint sources which was held from June 19-23 at Utah State University.

"Rationalizing Foreign Assistance with U.S. Agricultural Interests: A Policy Challenge for the 1990's" was the topic for a conference held by ISEC at the Louisiana State University Agricultural Center on April 6, 1988. The conference attracted a diverse audience of over 100 persons, including producers, professors, and State government officials. Speakers and panelists from various backgrounds noted that the economies of developing countries have the greatest potential for expanding U.S. farm product exports; and they encouraged greater agreement between U.S. policies on foreign assistance, trade, and agriculture.

A western regional training relevancy workshop was cosponsored by ISEC and the Consortium for International Development (a group of western universities involved in international agricultural training) at New Mexico State University, February 25-March 1. Workshop participants included faculty advisors and program coordinators who work with international agricultural students. Specific ideas on how to enhance training relevancy were explored within the areas of support services, curriculum, research, practical and supplemental training, professional integration, and reentry into the job market. Representatives from each campus developed action plans they will implement on their campuses to improve relevancy for foreign agriculturalists. A proceedings of the workshop has been published and widely distributed within the academic community.

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## FOREST SERVICE

Forest Service (FS) research develops scientific and technical knowledge to enhance and protect the economic productivity and environmental quality on all of America's 1.6 billion acres of forests and associated rangelands. Research results reduce the costs, improve the productivity, and enhance the efficiency of forest management while protecting or improving environmental quality.

FS research is conducted at eight regional forest and range experiment stations and the Forest Products Laboratory in Madison, WI. More than 2,800 studies are in progress at any one time, involving approximately 718 Agency scientists stationed at 74 locations.

### Fire and Atmospheric Sciences Research

Managers of forests and rangelands can now consult a computerized data base to find out how fire affects nearly 200 plant species and a dozen animal species in the West. The Fire Effects Information System documents how both wildfire and prescribed burning alter species distribution and characteristics and change resource values. These data help decisionmakers effectively use fire to manipulate vegetation for better management of range, wildlife, and timberland.

Concentrations of nitrogen oxides (NO<sub>x</sub>) are rising in the earth's atmosphere--a situation that can enhance the "greenhouse effect" and speed global warming. FS researchers recorded NO<sub>x</sub> fluxes from soil right after and 6 months after the burning of forests and rangelands. The high readings, plus the fact that between 2 and 5 percent of the planet's surface is burned every year, strongly suggest that the global NO<sub>x</sub> budget cannot be defined accurately without taking fire into account. This research should lead to a better understanding of the feedback mechanism operating between the formation of NO<sub>x</sub>, global warming, and fire occurrence, a chain of events that could threaten the long-term stability of forests everywhere.

### Forest Insects and Disease Research

Subterranean termites cause \$750 million worth of damage annually to homes and other wooden structures in the United States. The Environmental Protection Agency (EPA) recently suspended the use of several long-lasting termiticides developed in the 1960's. Anticipating such a ban, FS started 22 years ago to develop termite-killing chemicals that are less persistent. Our scientists found five alternative chemical treatments successful for at least 5 years--the minimum EPA standard. These five have been registered and labeled and are being marketed, offering U.S. families a safer alternative for protecting their largest single investment against this destructive insect pest.

"Acid rain" may be one of the causes of red spruce growth decline and premature death in the Northeast, but not by the simple mechanism of "burning" foliage. Researchers have found that the uptake from forest soils of calcium--a nutrient essential to plant growth--is blocked when acidic precipitation frees excess aluminum in the soil. When trees produce insufficient new sapwood, they become stressed and unable to withstand invasions of disease and insect pests. Better understanding of how trees are made more vulnerable by such mineral imbalances helps FS relate overall tree health to forest-management practices as well as to acidic deposition.

#### Forest Inventory and Analysis

Every 10 years, FS assesses the available supply of and future demand for all renewable resources under the auspices of the Forest and Rangeland Renewable Resources Planning Act (RPA). FS identifies potential timber resource problems and opportunities to expand timber markets based on 50-year projections of demand for wood products, including wood fiber for pulp and paper. For the 1989 RPA assessment, FS researchers developed a computer model that provides long-range projections of fiber consumption and technological change in the U.S. pulp and paper industry. FS forecasts substantial increases in the consumption of hardwood pulp and recycled fiber and moderate increases in the consumption of softwood pulp. Federal, State, and private industry officials can use this information in making policies and plans to meet timber resource needs for the next century.

Timber is the highest valued agricultural crop in the South, and timber-based industries employ more people and pay more in wages than any other manufacturing industry there. A comprehensive new study to assess the outlook for timber supplies in the South through 2030 indicates that the region can expect rising prices for timber and timber products, much lower rates of growth in timber harvests, and declines in employment and wages in the forest industries. But the study also identified ways to alter this picture through increased tree planting and more intensive management of the softwood resource. Public- and private-sector organizations will use the results of the southern timber study to plan the programs and policies that will shape the South's forests in the 21st century.

#### Research on Renewable Resources Economics

The Tax Reform Act of 1986 greatly affects timber owners by eliminating lower capital-gains tax rates for timber profits. Woodland owners, with help from their advisers, need to understand how changes in the U.S. Tax Code alter their own particular situations. FS economists analyzed the 1986 law and developed guidelines to help timber owners, operators, and investors minimize the adverse impacts of the new law and

maximize their use of the tax advantages still available for forestry investments.

In 1986, the Secretary of Agriculture asked FS to study the cumulative effects of timber sale levels on the economies of small, rural communities. A timber-supply study in Montana led to the development of an interactive computer program that allows FS employees and the public to get help in forest planning. The Montana Timber Market Model (1) estimates future prices and supply/demand for stumpage, and changes in employment and income in timber-dependent towns and (2) describes the characteristics of Montana's timber resource over time. The model is available through the FS computer system to FS users and on diskettes to members of the general public who have their own personal computers.

#### Forest Recreation Research

During the fifties and sixties, recreational use of wilderness increased at least 10 percent per year. But recent FS surveys indicate that the average annual increase has dropped to around 3 percent. At least some of the current growth is due to additions to the National Wilderness Preservation System, now six times as big as it was 15 years ago. Managers still have to cope with heavy use in many areas, but limiting public access and tight regulation of visitors seem less necessary now than in the late seventies, when visitor-days to the back country peaked.

Managers of forest sites have long noted that black city dwellers are underrepresented among users. Cooperative research with the University of Michigan has yielded a much clearer picture of the importance inner-city blacks place on the natural environment and the specific site attributes they prefer. Urban blacks tend to prefer sites characterized by openness, visibility, and neatness rather than dense vegetation. In contrast, whites prefer areas with little visible sky, dense woods with low branches, and understory vegetation. Urban blacks are also more likely than whites to prefer buildings on the sites. Awareness of these preferences can help planners and managers provide forest recreation environments that will encourage use by urban blacks.

#### Research on Trees and Timber Management

Usually, herbicides are just as fatal to desirable tree species as to nearby weeds. But by employing tissue-culture techniques ("cloning"), FS scientists have developed a hybrid poplar that can withstand laboratory applications of two widely used herbicides. Tests will begin in 1989 to determine how well these genetically selected trees perform in the field. Production of other herbicide-tolerant trees, such as high-quality hardwoods, could further accelerate tree-growing for the benefit of the pulp, paper, and fuelwood industries.

FS founded a research consortium in 1979 under the U.S. Man and the Biosphere Program to seek balanced solutions to the problems of tropical deforestation. Under the direction of a scientist from FS' Institute of Tropical Forestry in Puerto Rico, the consortium funded 20 tropical studies costing around \$1 million, mostly from FS funds. This research has so far yielded over 60 papers on ecology and forestry/agroforestry. Papers from the recently published "People and the Tropical Forest" suggest that humankind can be cautiously optimistic about the future of tropical forests. Specifically, this research has identified sound management principles that take into account local cultures, use of sustained-yield techniques where such use was not thought possible, and unproductive or damaging practices that should be set aside. Considering the importance of tropical forests in maintaining Earth's atmosphere, everybody on the planet stands to benefit from this research.

Watershed  
Management and  
Rehabilitation  
Research

Management of America's water resources is especially critical in the West, where snowfall greatly affects streamflow. In heavily forested areas, FS researchers have found that much of the snow caught on tree branches simply evaporates. Clearcutting leads to much higher streamflow, but studies at the Fraser Experimental Forest in Colorado have shown that partial cutting (individual tree removal), which is more environmentally acceptable, can enhance water supplies too.

Managers know that competing vegetation (weeds and unwanted tree species) affects forest productivity, but until FS developed SYSTUM 1, they could not estimate the seriousness of the competition in a given stand. SYSTUM 1 is a microcomputer growth simulator--a program that mathematically "grows" a group of trees and models their growth interactions with shrubs under different levels of weed control. Not only can SYSTUM 1 help managers pick the best silvicultural regime to achieve their goals, it can predict how silvicultural treatments will affect wildlife habitat.

Research on  
Wildlife  
Habitats

FS research has revealed that for populations of the red-cockaded woodpecker to increase, forest managers need to resist clearcutting and, instead, leave some mature pines. This bird species digs out nesting cavities in 80- to 120-year-old pines, probably because such trees exude quantities of a sticky resin that keeps away egg-eating predators like the rat snake. Selectively leaving behind uncut trees ("modified shelterwood harvesting") produces the kind of open pine savannah habitat that this bird prefers and also assures a seed source and protection of seedlings for the regeneration of pine stands that will furnish wood in the 21st century.

Many owners of forest land in the South want to grow pine trees and provide forage for farm animals as well, but heavily stocked pine stands do not permit luxuriant vegetation to grow beneath the forest canopy. FS researchers discovered that wide-row and multiple-row pine planting configurations are compatible with forage production. This multiple-use approach to land management supports food and timber production while enhancing recreation and wildlife habitat.

Forest Products and Harvesting Research

Forest-management activities such as roadbuilding and preparation of timber sites for harvest can cause surface erosion and sediment production in streams and channels. FS scientists, working with the USDA's Agricultural Research Service and Soil Conservation Service and the Department of the Interior's (USDI's) Bureau of Land Management, used simulated rainfall to compare sediment production from soils differing vastly in type and management practices on sites in the Rocky Mountain West and Southeast. The payoff: a process-based computer model that will let forest managers gauge the impact of land-management activities on the environment, ensure maintenance of long-term soil productivity, and determine environmentally sound and cost-effective management practices.

FS builds or reconstructs 8,000 miles of forest roads annually, and finding cheaper ways to do this without compromising the forest environment is a high priority. Agency scientists have developed a way to make new forest roads out of fist-sized "chunkwood"--what's left after a wood chunker gobbles up the trees cleared to lay the roadbed. This new road material performs well in swamps, in both wet clay and dry sandy soils, and in mudholes in conventional roads. Using chunkwood will reduce our roadbuilding costs, conserve gravel resources, eliminate unsightly gravel pits, and provide a market for the otherwise unmerchantable trees cleared for the roadway.

International Forestry

The International Forestry (IF) Staff provides leadership, coordination, and direction for FS activities with other countries and international organizations. In 1988, IF--

- o Expanded cooperation with the United Nations Food and Agriculture Organization through its Tropical Forestry Action Plan.
- o Advanced 26 cooperative research projects in 7 countries. The projects addressed new technologies in agroforestry, fire management, wildlife management, protection against insects and diseases, forest regeneration, tree genetics, watershed management, and forest products utilization.
- o Participated in 18 science and technology exchanges with 11 countries in eastern and western Europe, Asia, Oceania, and

Latin America. FS gained new tree and insect germplasm, data on atmospheric deposition, new forest-products manufacturing technology and marketing methods, access to unique equipment for modeling stream channel morphology, and new management approaches to urban forestry and parks.

- o Hosted more than 300 forestry/natural-resource students and professionals from 50 other countries, including 30 participants in the Fourth Annual International Seminar on Forest Resource Administration and Management.

IF works closely with the U.S. Agency for International Development (AID) and the USDA Office of International Cooperation and Development in two programs established primarily to assist developing countries.

#### The Forestry Support Program--

- o Supported major agroforestry training activities in Bolivia, Costa Rica, and St. Vincent. In cooperation with the Cooperative for American Remittances to Everywhere, Inc. (CARE), IF helped develop an agroforestry extension handbook and (with Save-The-Children) the publication "Planning for Agroforestry."
- o Prepared a biological diversity assessment for USAID in Morocco and helped draft a similar assessment for AID in Botswana.
- o Maintained the résumés of 2,500 natural resource managers on a skills roster and completed nearly 150 computer searches to identify resource specialists for international forestry assignments.

#### The Disaster Assistance Support Program--

- o Sponsored and implemented major international fire-suppression training courses in Ghana, Mexico, and Indonesia.
- o Provided personnel to AID for continuing grasshopper and locust control activities in Mali, Mauritania, Morocco, Tunisia, and Sudan.
- o Furnished a geologist to AID to conduct a landslide hazard assessment in St. Vincent and the Grenadines.
- o Conducted disaster simulation exercises, training, and workshops in Arizona; Maryland; Washington, DC; Argentina; Costa Rica; Venezuela; and Thailand.

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## FEDERAL GRAIN INSPECTION SERVICE

The Federal Grain Inspection Service conducts applied research in the process of fulfilling its mandate to administer the Nation's grain inspection and weighing system. FGIS is an action-oriented agency with responsibilities to develop (1) new or improved methods and equipment for grading, inspecting, and weighing grain; (2) inspection standards; (3) inspection and weighing procedures; and (4) other grain-marketing services and programs. FGIS and the Agricultural Research Service (ARS) jointly cooperate in establishing policies, responsibilities, and procedures for research in grain marketing. The Director, Quality Assurance and Research Division, shares with the Administrator the ultimate responsibility for overall planning, research, and related support programs and activities assigned to FGIS.

FGIS manages research within the Agency by reimbursable agreement with ARS or by contract with any acceptable vendor through the contracting capability of the Animal and Plant Health Inspection Service. Projects for which the personnel and equipment are available or reasonably obtained are handled within FGIS.

### Soybean Protein and Oil

Research continues on the use of near infrared reflectance as a tool to determine the quantity of oil and protein in soybeans. Recently, FGIS determined that near infrared transmittance is an acceptable technology to determine these constituents. The present transmittance technology allows the analysis of whole soybeans as compared to ground soybeans. Analyzing whole soybeans saves considerable time per test. FGIS is scheduled to offer protein and oil analytical services beginning September 1989.

### Grading of Wheat by Hardness

Determining wheat hardness by near infrared reflectance spectroscopy and by single-kernel hardness testers continues to be a high priority project for FGIS. Using the recommendations of the Wheat Classification Working Group, FGIS is evaluating wheat crops from every region of the country and comparing the yearly results. The purpose is to obtain data on how wheat in regular channels would be graded if a hardness factor for differentiating between classes were used.

### Mycotoxins and Pesticides

Rapid procedures for determining the presence of aflatoxin in corn have been investigated, and the results are being statistically evaluated. The primary objective is to replace existing methods with a rapid, safe, and reliable method to determine aflatoxin. FGIS will implement a new method if it meets the above criteria. In addition, FGIS is evaluating existing rapid pesticide-testing procedures with the purpose of developing a procedure that can be readily applied to grain analysis.

Moisture, Protein,  
Starch, and Oil  
in Corn

The early stages of calibration for moisture, protein, starch, and oil in corn are being performed. The purpose is to provide more objective testing for grain and to provide test results that are meaningful to end users.

Determination  
of Insect  
Infestation

Promising research is being conducted on new diagnostic techniques known as ELISA to detect insects and insect fragments in grain and processed grain products. Preliminary research indicates that ELISA can quantitate the content of insect matter. Work is continuing on using x rays to detect internal infestations. The x-ray technology is being researched by ARS. ARS has also produced an acoustic sensing device to detect insect movement in grain samples. FGIS will evaluate this technology for use as a screening tool to detect insect infestation.

Toxicity of  
Weed Seeds

The toxicity of five different weed seeds that commonly contaminate grain is continuing to be researched by ARS for FGIS. This is a long-term and extensive animal-feeding study that involves growth- and development-related examinations and postmortem tissue and organ studies. Four seed studies have been completed.

Image Analysis

Image analysis is continuing to be researched as a means to classify wheat and possibly other grains and oilseeds. A variety may still possess some physically identifiable characteristics even though they are not apparent visually. ARS is conducting this research in support of FGIS.

Single-Kernel  
Moisture

Development and evaluation of single-kernel-moisture procedures and instrumentation continue. Dielectric, nuclear magnetic resonance, and microwave procedures are continually being investigated. A single-kernel moisture tester using dielectric technology shows promise for the grain inspection system. Tests are presently being carried out on a single-kernel moisture tester, and a recommendation should be available by late summer.

Identification  
of Grain Odor

Progress has been made in the development of instrumentation to determine grain odor. This project has a high priority and is being performed by ARS for the benefit of FGIS. Odors are highly complex mixtures of organic volatiles. Identification of the volatiles responsible for a particular odor is an extremely involved project. New data show that certain classes of organic volatiles have been isolated. Further refinement of the methodology should allow grain analysts to objectively determine odor in grain.

TCK Spore  
Detection

Recent controversy over the accurate detection of TCK smut spores in wheat has caused the initiation of research into improved TCK detection methodology. FGIS and ARS are jointly

evaluating some new techniques to detect TCK. FGIS has performed the initial research by using a fluorescent-light-microscopy method. Fluorescence microscopy enables the analyst to differentiate among several different types of spores that normally have been perceived to have the same characteristics.

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## EXTENSION SERVICE

The Cooperative Extension System (CES), celebrating a 75th Anniversary in 1989, is a national educational network linking research, science, and technology to the critical issues and needs of people where they live and work. Extension education combines the expertise and resources of Federal, State, and local governments, and cooperates with other public- and private-sector agencies and groups in its programs. The System is a unique three-way partnership between the Extension Service of USDA (ES-USDA), Cooperative Extension Services in each State and Territory, and local Extension offices in nearly all of the Nation's 3,150 counties.

CES leadership refocused resources through (1) issues programming in 1988, and (2) a new Systemwide strategic planning process. It has also strengthened each of nine CES national initiatives by creating additional linkages with private and public organizations. Examples of how CES is addressing these issues follow.

### Competitive Agriculture Spotlighted

The national initiative Competitiveness and Profitability of American Agriculture focuses on integrated farming and marketing systems, global competitiveness, and biotechnology. For example,

- o Extension sponsored a national workshop to launch a total-systems approach within the beef industry.
- o ES-USDA worked with the Cooperative State Research Service (CSRS) in allocating \$3.9 million for projects to develop low-input/sustainable agricultural systems.
- o ES-USDA joined the Office of Governmental and Public Affairs and CSRS in four regional biotechnology workshops; and then, through a national teleconference, local, State, and national Extension staff examined Extension's role in biotechnology.
- o California Extension developed a sustainable-agriculture project, called Grass to Grill, that is helping ranchers produce leaner lamb with less synthetic nitrogen fertilizer.
- o Kentucky Extension pioneered the successful no-till farm management practice and, today, leads the Nation in number of no-till acres.
- o GOSSYM/COMAX, a cotton-growth computer program that helps farmers make decisions on irrigation, fertilizer, and harvesting, can earn farmers \$47 more per acre. The program is currently being used by 250 farmers from North Carolina to California.

## Alternative Opportunities Explored

The Alternative Agricultural Opportunities national initiative defined three critical issues: the alternative marketing, management, and production of traditional crop and livestock products; the marketing, management, and production of alternative products or services; and off-farm employment or entrepreneurship compatible with a continuing farm operation. Advances in this national initiative include the following:

- o North Carolina Extension staff have led in transforming a one-crop (tobacco) agriculture into the Nation's third most diversified agriculture; farmers now produce around 70 different commodities worth over \$4 billion.
- o Louisiana Extension developed preservation and marketing strategies for the State's \$70 million crawfish industry based on 135,000 acres shifted by farmers from traditional row crops.
- o After the collapse of the area's sugar beet and malting barley industries in 1986, Extension agents helped three western Colorado counties develop production of broccoli and sweet corn into a significant economic force.
- o New Mexico Extension county agents have organized marketing associations for chile and pinto beans and have established demonstration plots of specialized crops such as cauliflower, raspberries, and tayberries.
- o The Farmer's Market Line, developed by New Jersey Extension county agents, is a computer-based information exchange service that brings together buyers and sellers of agricultural commodities.

## Extension Focused on Revitalization

The Revitalizing Rural America national initiative focuses Extension resources on developing the long-term capacity of individuals, families, businesses, and communities to compete in a global and changing economy. Active Extension revitalization and economic development programs exist throughout the country, for example,

- o Extension's industrial development program in Arkansas resulted in creating over 700 new jobs valued at more than \$9.6 million, 6 new industries, 7 industrial parks, 12 expanded industries, and 4 retained industries. Its tourism program brought about five new businesses and four new festivals, for a total dollar impact of \$528,000.
- o Nebraska Extension's Managing Main Street Business program has enabled over 1,000 people in 518 rural businesses to improve operations and profits; over half increased profits an average of 9.5 percent.

- o Ohio Extension's Business Retention and Expansion program has helped 39 rural communities and 7 cities attract and keep businesses.
- o Massachusetts Extension staff worked with 21 towns to develop forest management plans for 52,000 acres that will earn \$2.4 million more in timber sales than before.
- o In 1988, Michigan Extension trained over 2,000 local leaders plus 90 new county commissioners to improve decisionmaking skills, thus saving taxpayers almost \$1.5 million through more accurate analysis by government units and associations.

National  
Resources  
Highlighted

For the Conservation and Management of Natural Resources national initiative, CES joined the American Forestry Association in holding a major conference on the status of the Nation's renewable natural resources. This conference set the stage for determining priority policy and program directions for the next decade.

Accomplishments in the field of natural resources include the following:

- o In West Virginia, Extension's program for renewable natural resources and wood industry resulted in over 800 jobs through an expanding wood industry. Other results include the establishment of three new kiln facilities, a hardwood flooring plant, three new moulding and millwork manufacturers, and other, smaller facilities.
- o "Great American Woodlots," a 13-part video series on woodlot management produced by Maine Extension, went by satellite to viewers nationwide.
- o A Massachusetts Extension project with the State's fish processing industry is turning fish wastes from a costly disposal problem to a resource as a fertilizer.

Water Quality  
Management  
Encouraged

Consistent with the national initiative on water quality, Extension staff conducted a national workshop and prepared a major policy paper on water quality and management. Extension is addressing the issue of the impact of agricultural chemicals on water resources. Programs are encouraging rural residents to test their water-supply wells. Some achievements already made are as follows:

- o Over 300 Iowa households have improved water quality based on research from Extension's Big Spring Basin Demonstration Project.

- o Two low-water-demand demonstration gardens developed by Extension in northern Nevada urban communities helped reduce water use 20 percent in 1988.
- o To help reduce nonpoint-source pollutants in the Chesapeake Bay, Maryland Extension developed nutrient management kits, an information campaign, and a demonstration farm.

Initiative  
Focused on  
Nutrition

The Nutrition, Diet, and Health national initiative identifies two critical areas: (1) dietary practices related to lifestyle factors and health and (2) confidence in the safety, quality, and composition of the Nation's food supply. Developments in this national initiative include the following:

- o In 1988, reports from 21 States and 2 territories indicated Extension had reached over 1.8 million adults and youth with nutrition, diet, and health programs.
- o New Hampshire's major thrust, Cancer Risk Reduction Education, enhanced with a \$40,000 grant from the State's Division of Public Health Service, reached almost 5,000 people through direct contact and over 460,000 people through mass media.
- o California Extension produced five videotapes on chemicals in the human food chain; they feature scientists, farmers, and others discussing sources of chemicals in food, alternatives to chemical use, and regulatory issues.
- o Georgia Extension is a major sponsor of the Sunbelt Agricultural Exposition, the South's biggest farm show; and in 1988 Extension specialists and county agents provided nutrition assessment counseling to almost 1,700 participants.
- o A University of California-Davis Extension specialist is developing a "guilt-free" egg, by extracting its cholesterol without altering taste or nutritional value.

Initiative  
Focused on  
the Family

Programs under the Family and Economic Well-Being national initiative brought together 542,000 people in 35 States and territories as they sought help in managing economic and social stress. An additional 22 million persons were reached on these issues through mass media. Activities pursued under this national initiative include the following:

- o The District of Columbia Extension has established a \$96 million project, Infant Mortality, that provides one-on-one information to nearly 500 participants on prenatal care, nutrition during pregnancy, parenting, and substance abuse.

- o Maryland Extension staff annually train 350 financial counselors who work with thousands of families to develop budgets, prorate debts, analyze insurance, and start savings plans.
- o With a special State appropriation, Tennessee Extension helped over 2,150 farm families weather financial difficulties during the recent and lingering farm financial crisis.
- o Rhode Island Extension volunteers research and answer over 8,000 telephone calls yearly on the statewide 800 Consumer Education/Home Horticulture Hotline; the volunteers are housed in the Cooperative Extension Education Center at the University of Rhode Island.

Human  
Capital  
Advocated

The Building Human Capital national initiative identified four critical issues: facilitating career preparation and transition; developing leaders; renewing volunteerism; and preparing youth for responsibility. A national teleconference initiated Extension involvement in "Making the Grade," a national report card on youth. The report card was promoted by the National Collaboration for Youth, of which the 4-H program is a part. New program thrusts are under way: establishment of an agricultural science career institute, development of family job counseling clinics, and youth as advocates for youth.

A model Family Job Skills Workshop and Job Fair, planned in 1988, was held in Macon, GA. Fifteen business and industry representatives talked with young participants about their future in the job market; how-to workshops included job application and interview, and where to job-hunt. This first effort is to be used by other States or regions as a guideline for similar nationwide efforts.

With increased behavior problems in youth (substance abuse, teen pregnancy, and suicide) Colorado State University developed the DARE To Be You program. This nationally recognized program was given to over 18,000 youths and adults by a team of volunteers in 14 Colorado counties. The initial 2-year program evaluation showed a 15-percent lower onset of substance use in an experimental group over a controlled group, with a significant increase in self-control, decisionmaking, and communication skills; some increases in self-esteem were also evident. The Career Options for Rural Missouri Families Extension program has helped 865 adults in 33 rural communities with job-search and career-transition skills since 1987.

"Youth  
at Risk"  
Defined

Youth at Risk is the newest national initiative. Initiative task force members met with key national, State, and local decisionmakers and corporate leaders to identify critical issues and explore cooperative ventures. Eight critical areas of priority needs in the education of youths were identified: self-esteem, careers and employment skills, fitness and health, reading and technological literacy, parental support, child care, problem solving and decisionmaking, and futuring. Advances in these areas include the following:

- o In one of the eight areas, Extension is licensed through the Adventure program in Missouri to provide afterschool care at several sites.
- o In the self-esteem need area, Extension and the medical faculty at the University of Minnesota have developed a joint program, Tackling Tough Stuff, that focuses on reducing teen depression and suicide.
- o In the fitness and health needs area, Georgia Extension has established several substance abuse programs including a statewide institute for 1,000 youths and also prevention and intervention programs for youths at risk in 13 counties.
- o The Oklahoma Department of Corrections works jointly with Extension in an alcohol abuse program for first-time offenders.
- o Kansas Extension originated 4-H CARES, a national substance-abuse-prevention program that emphasizes self-worth and assertiveness skills, used now in 37 States.
- o An Arkansas pregnancy prevention and teen parenting program reached 10,000 youths in school classrooms and 64,000 more through a targeted community school newsletter.
- o The Indiana Mentor Mother program pairs teen mothers and adult volunteers for counseling and education.
- o A Michigan 4-H program, SPACES: Preparing Kids for High Tech and Global Future, covers more than one priority needs area, as it addresses inner space (personal coping and creative skills), outer space (advanced technology), and shared space (global and cultural issues).

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## NATIONAL AGRICULTURAL LIBRARY

The National Agricultural Library (NAL) serves as the Nation's chief agricultural information resource and service. It provides to the Department and the Nation needed information concerning agriculture, rural development, aquaculture, human nutrition, and related sciences. The library collects information from all over the world, with almost 2 million volumes now in its collection. NAL disseminates information to scientists, administrators, educators, and farmers through its reference and lending services and through specialized information centers and a network of State land-grant and field libraries. NAL is augmenting its dissemination capabilities with sophisticated computer, laser, and optical technologies. It also serves as the U.S. center for an international agricultural information system.

### Proactive Information Delivery

NAL's information centers, now numbering 13, have been established to serve specialized clientele in high-interest subject areas.

The special focus on a rather carefully defined and limited area has resulted in a dynamic and anticipatory role for center staff. Their charge is to identify and reach out to their clientele. For this purpose they use the techniques and testing of the latest technology to develop and present products responding to and anticipating the information needs of their clientele.

Five centers of particular importance currently are profiled in this report: (1) The Alternative Farming Systems Information Center, (2) The Animal Welfare Information Center, (3) The Aquaculture Information Center, (4) Rural Information Center, and (5) The Youth Development Information Center.

### Alternative Farming Systems Information Center

The Alternative Farming Systems Information Center (AFSIC) provides information concerning a congressionally mandated program on low-input/sustainable agriculture (LISA), coordinated by the USDA Cooperative State Research Service. The information products and services, some developed in cooperation with interested organizations, are aimed at investigators for low-input methods, Extension workers and educators, and the actual practitioners, the farmers.

New projects include a series of videotaped oral history interviews with key figures in the sustainable agriculture field, one of which has been completed, and a how-to pamphlet series, still in preparation, directed at small farmers. These and other projects are partially the result of constant networking activities between AFSIC and related outside organizations and individuals.

Evidence of the mushrooming interest in low-input agriculture and sustainable agriculture, called by some experts the farming systems of the future, can be seen both in the ever-growing number of requests to AFSIC for information and in the large attendance at 1988 national and international conferences on sustainable agriculture, with other conferences announced for 1989. As part of its outreach program, AFSIC participates by speaking or exhibiting at these conferences. In 1988--

- o An average of 50 requests per month for information were researched and answered, and almost 400 requested information products were sent out monthly.
- o Thirty or more extensive bibliographies were produced from the AGRICOLA data base, covering such topics as "Legumes in Crop Rotations," "Organic, Low Input, or Sustainable Agriculture," and "Water-Conserving Irrigation." These are updated and reissued yearly as new information becomes available. Brief online searches are also part of the reference services, while indepth searches are done on a cost-recovery-fee basis.
- o Work was done with other organizations, Government agencies, and individuals in the LISA program to provide information to farmers who are either applying alternative, resource-conserving methods or considering applying those methods because of economic or environmental concerns.

Animal Welfare  
Information Center

NAL formed the Animal Welfare Information Center (AWIC) to provide a coordinated and focused information service in the field of welfare for experimental animals. In 1988 this center--

- o Produced 18 information products on various topics related to animal welfare (e.g., "Animal Models of Disease," "The LD50 (Median Lethal Dose) Toxicity Test," and an Animal Welfare Information Center brochure).
- o Attended and/or exhibited at 13 major national and regional conferences held for users of experimental animals.
- o Made numerous presentations and orientations to both Government and non-Government audiences.
- o Initiated the filming of a videotape on the center to distribute nationally.
- o Issued five informal grants and three cooperative agreements for the development of information products, including a microcomputer-based expert system focusing on anesthetizing

Aquaculture  
Information  
Center

of laboratory animals, and a videotape program on alternatives in animal research.

The Aquaculture Information Center has been involved in a variety of projects during FY '88. Supplemental funding from a number of cooperating agencies allowed the center to improve services and to produce a wide variety of information resources for aquaculture uses. The center--

- o Created an expert advisory system on aquaculture named "AquaRef."
- o Participated in a national text-digitizing project to store aquaculture literature on mass-storage media.
- o Networks with national and international libraries and information centers.
- o Works with the Food and Agricultural Organization (FAO) in an international project to create Expert System on African Aquaculture.
- o Cooperates in an international aquaculture project to improve the indexing and availability of aquaculture publications.
- o Works on specialized projects with the Joint Subcommittee on Aquaculture.

Rural Information  
Center

The Rural Information Center (RIC), established in September 1987, provides information and referral services to local government officials, businesses, community organizations, and rural citizens working to maintain the vitality of America's rural areas. The information and services available through RIC are easily accessible to local leaders and Government officials through the Cooperative Extension Service (CES) network of county and State offices. In May the Extension Service (ES)/USDA expanded RIC services nationally to the CES by inviting it to participate in the RIC project and designate a RIC State coordinator. Currently 45 States and Guam are actively participating in the RIC project.

- o RIC established a graduate internship program with the Center for the Study of Rural Librarianship, Clarion University of Pennsylvania, Clarion, PA.
- o NAL/RIC and the Center for the Study of Rural Librarianship, Clarion University of Pennsylvania, cosponsored the Information and Rural Economic Development Conference in May. The purpose of the conference was to explore what constitutes the information infrastructure of rural America.

- o RIC promoted services nationally at eight conferences, providing presentations and exhibits.
- o A monitoring and analysis system will provide the capability to track and describe future rural issues and information needs by analyzing RIC inquiry data along with other available future or strategic planning information. Implementation is expected in FY 1989.

Youth Development Information Center

The newest center, established in July 1988, is the Youth Development Information Center (YDIC). It provides information services to youth development professionals who plan, develop, implement, and evaluate educational programs designed to meet the changing needs of America's youth. The target users of the center are Cooperative Extension staff, youth-servicing agencies and organizations, and individuals researching youth development. The National Association of Extension 4-H Agents cooperates with NAL as part of a system to review, abstract, and update materials for a collection known as 4hprk (4-H professional research and knowledge). The records for these materials are specially coded in the AGRICOLA data base for easy retrieval. In 1988 YDIC--

- o Coordinated collection development and communication with a nationwide network of Extension professionals with the Federal ES and 4-H staffs.
- o Worked with professionals in youth-serving organizations throughout the country to identify and acquire materials for the collection and for center promotion.
- o Identified current trends and information needs of youth-development professionals in order to respond with timely information products.
- o Developed promotional materials and exhibits for use at national and regional conferences and meetings.
- o Conducted three seminars introducing the new center to the State presidents of the National Association of Extension 4-H Agents.
- o Conducted a seminar introducing the new Center to national representatives of the National Collaboration of Youth.

Improved Information Access Through Optical Technology

Access to the written records of agricultural research, education, and accomplishment is essential for effective development in all phases of agriculture. Much of the agricultural literature is not easily accessed. Some is likely to disappear entirely through deterioration of the medium

(paper) on which it is printed. NAL, cooperating with 44 land-grant-system libraries, has established the National Agricultural Text Digitizing Project to improve and ensure access to significant agricultural works by using new electronic and optical technology. Printed text and images from 4,000 pages of aquaculture publications have been scanned and put into digital, computer-manipulable form, and mastered to a compact disk (CD-ROM). Other disks will cover material on acid rain, international agricultural research material from the Consultative Group on International Agricultural Research (CGIAR), the Agent Orange collection at NAL, and material on food irradiation. The text can be easily and readily searched by any word or words in the publication and then printed, and the image of the page can be displayed when illustrations need to be viewed, and so forth. Possibilities for electronic document delivery of the digitized collections via telecommunications networks will be examined. This medium holds promise to be more permanent than paper for preserving agricultural literature, and the text should be much more easily read than text contained on microform.

Cooperation for Availability of and Access to State Publications

Cooperative processing projects not only increase availability and accessibility of publications but focus on needs as seen by the agricultural library community throughout the country. An example of cooperative processing is the NAL/Land-grant/State Agricultural Publications Program. Agricultural publications of the States--primarily from the experiment stations, Extension services, and college agriculture departments--are an important and heretofore often unseen source of information. To make them visible and available, NAL and many land-grant university libraries established a program to record, announce, and make available these publications. Currently, land-grant university libraries in 43 States are participating in this program. The participants cooperate in the acquisition, cataloging, indexing, and provision for delivery of these agricultural publications. Citations produced are contained in NAL's AGRICOLA data base and in the international agricultural data base AGRIS, coordinated by the Food and Agricultural Organization.

Expert Systems for Convenient Reference Help

Answers provided by reference experts are limited by the availability and accessibility of the experts. To provide an alternative and supplement to human experts, NAL is creating small-scale microcomputer systems mimicking the advisory work done by humans. These systems guide users to appropriate references--books, articles, laws, and so forth--or, in some instances, to answers to the questions. Reference advisors have been developed on aquaculture, food and nutrition, online search strategies, and expert systems. Several, developed in cooperation with land-grant university libraries, cover Louisiana aquaculture, organic chemistry, and urban forestry. A

system addressing the anesthetizing of laboratory animals is being developed with the University of Maryland library; and one addressing African aquaculture, with the Food and Agriculture Organization of the United Nations in Rome. These systems may be developed in any subject area. They can be available at all times in many locations and at no cost to users.

**Electronic Bulletin Board System for Information Exchange**

ALF (Agricultural Library Forum), the National Agricultural Library's new microcomputer-based electronic bulletin board system, provides electronic access to information about NAL products and services and serves as a focal point for networking activities for those who dispense and use agricultural information. ALF is open to all those interested in exchanging ideas, sharing resources, and seeking advice or assistance on agricultural library and information issues. Users interact with ALF using three basic types of communications: bulletins, messages/conferences, and file transfer. Bulletins contain information about library programs, services, contacts, and other reference materials of general interest. Conferencing enables callers to participate in special-interest group discussions. Public conferences such as AGRICOL, a roundtable for AGRICOLA data base users, and private conferences requiring special registration are available. Subject matters of conferences currently active include water quality, biotechnology, and animal welfare. ALF is intended to play a role in networking agriculture's wealth of information among its diverse user community.

**Computer-based Interactive Instruction on Searching Data Bases**

Instructor-led education is limited to the location where the instructor is present, and it is transitory; that is, it cannot be repeated. NAL with the University of Maryland, Center for Instructional Education and Development, has produced an instructional program on how to search data bases. It runs on an IBM-AT-type personal computer with videodisk player. The program is intended primarily for independent use and is completely self-instructional. It enables users to learn how to perform simple author-title searches or indepth subject searches, to simply become familiar with online systems, or to search data bases in general. The user interacts directly with the system, determines his/her own pace, and may review or repeat as needed. Such interactive systems have resulted in high student motivation, sometimes higher than that in instructor-led classes. Other AGRICOLEarn systems will be developed; and these systems will be placed in various locations throughout the country and will also be available for short-term loans upon request.





